

# **User Guide**

## **BIOSUSB User Guide**

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# 1 Introduction

The BIOS USB Package (based on JUNG0 USB stack) provides capability to incorporate a USB host or USB device functionality for an embedded device. This document describes the USB host and device stack architecture, installation procedure and example use cases in TI BIOS environment.

The BIOSUSB package supports both CCS3 and CCS4 for the following platforms

- C6747/OMAPL137
- C6748/OMAPL138

## 1.1 Terms & Abbreviations

Term	Description
API	Application Programming Interface
Port	Platform and Operating system abstraction layer
JOS	USB general services module
USB Device	Platform capable of performing USB device functionality
USB Host	Platform capable of performing USB host functionality
MSC	Mass Storage Class
USB	Universal Serial Bus
USBware	Product name of Jungo's USB host and device stack

## 1.2 References

#	Document	Description
1	usb_device_stack.pdf	USBware device stack details
2	usb_host_stack.pdf	USBware host stack details
3	mass_storage_class_driver.pdf	USBware mass storage driver details
4	mass_storage_fd.pdf	USBware mass storage function driver details
5	hid_class_driver.pdf	HID Class driver details
6	hid_keyboard_fd.pdf	HID keyboard function driver details
7	hid_fd_lib.pdf	HID function driver library reference

## 2 Installation Guide

This chapter discusses the BIOS USB package installation procedure and how to configure and run the usb host or device sample example provided along with the package, refer to section-6.

### 2.1 System Requirements

The following products are required to be installed prior to using the BIOSUSB Package for C6747/OMAPL37 and C6748/OMAPL138 platform:

#### For CCS3 Environment

- ❖ CCS 3.3.80.11 (service release 10)
- ❖ DSP-BIOS versioned **5.41.02.14**
- ❖ Code Generation Tools **6.1.9**
- ❖ EVM C6747/OMAPL37 (Rev-D recommended) or C6748/OMAPL138 Board (Beta- version recommended)
- ❖ XDS 510 USB Emulator (Optional) – EVM has on board emulator

#### For CCS4 Environment

- ❖ CCS4 version 4.0.0.16000
- ❖ DSP-BIOS versioned **5.41.02.14**
- ❖ XDS 510 USB Emulator (Optional) – EVM has on board emulator

#### Dependent Packages

- ❖ EDMA 3 LLD – versioned **01.11.00.02**
- ❖ ERTFS File System package versioned **1.10.00.30 or higher version**
- ❖ PSP\_DRIVERS Package - The BIOSPSP GA Package with versioned **1.30.00**

### 2.2 Installation and configuration of dependent packages.

BIOS USB package is dependent on the following packages and as such expects these packages to be installed and configured correctly prior to its installation and usage.

- I. **EDMA3 LLD** Driver package
- II. **RTFS package** – Required for BIOS USB Host functionality. RTFS package is needed for supporting MSC devices such as USB sticks, USB HDD's etc.

#### **III. PSP\_DRIVERS Package**

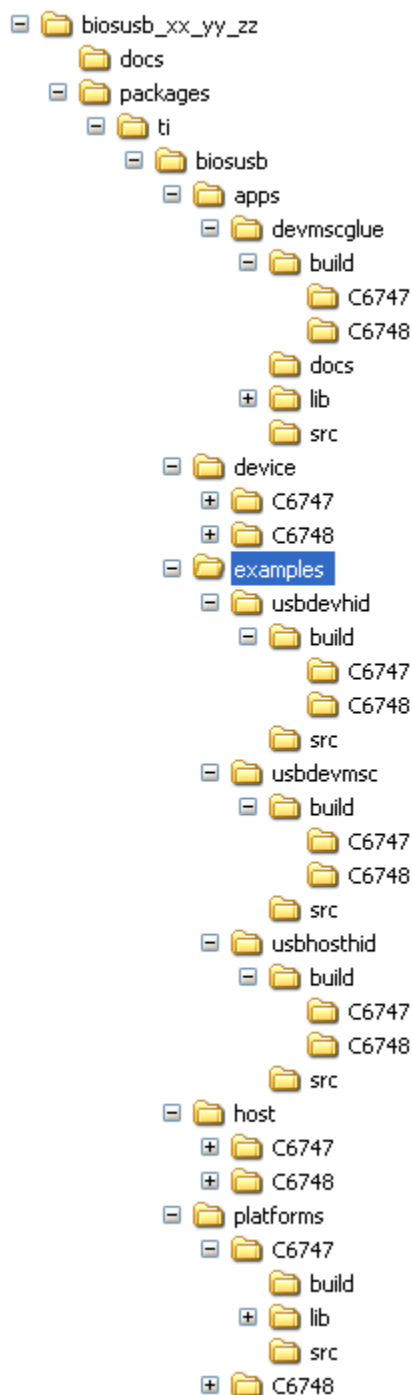
1. Install EDMA-3 LLD Driver into preferred drive/folder. Please refer the EDMA3 package installation guide. The environment variable 'EDMA3LLD\_BIOS5\_INSTALLDIR' is used in the sample application projects for referring to the EDMA3 driver libraries. This environment variable is created and updated by the EDMA3 LLD driver during its installation. Please ensure that this environment variable is pointing to the EDMA3 LLD install directory intended to be used along with this package. This is more important when there are multiple EDMA LLD installations as the installer updates this environment variable with latest installation version. (eg. If EDMA LLD driver is installed into c:\edma3\_lld\ the environment variable is set to EDMA3LLD\_BIOS5\_INSTALLDIR=c:\edma3\_lld).



2. Install the RTFS Driver into preferred drive/folder. Please refer to the RTFS package installation guide. The environment variable 'RTFS\_INSTALL\_DIR' is used in the sample application project for referring to RTFS driver libraries. Please ensure that this environment variable is pointing to the RTFS install directory intended to be used along with this package.
3. Install BIOSPSP Package Driver into preferred drive/folder. Please refer to PSP driver's installation procedure. The environment variable 'PSP\_DRIVERS\_INSTALL\_DIR' is used in the sample application project for referring to libraries of PSP components like block media, PSC, platforms, MMC/SD, NAND, I2C etc. Please ensure that this environment variable is pointing to the install directory of PSP component intended to be used along with this package. (eg. If BIOSPSP package is installed into c:\pspdrivers\_1\_30\_00\_06\ the environment variable is set to PSP\_DRIVERS\_INSTALL\_DIR = c:\pspdrivers\_1\_30\_00\_06).
4. Install the BIOS USB package using the self extracting installer. Figure-1 shows the directory structure of BIOS USB Package after the installation. The installer will create BIOSUSB\_INSTALL\_DIR environment variable pointing to BIOSUSB installation directory. This environment variable is used in USB Host MSC application examples of RTFS package.

### 3 Folder Structure

Figure 1 illustrates the folder structure and placement of the BIOS USB package.



**Figure 1:** BIOSUSB directory structure

The folder 'biosusb' contains the following components

- USB stack for Device and/or Host mode as applicable
- Example application for demonstrating USB functionalities
- USB applications

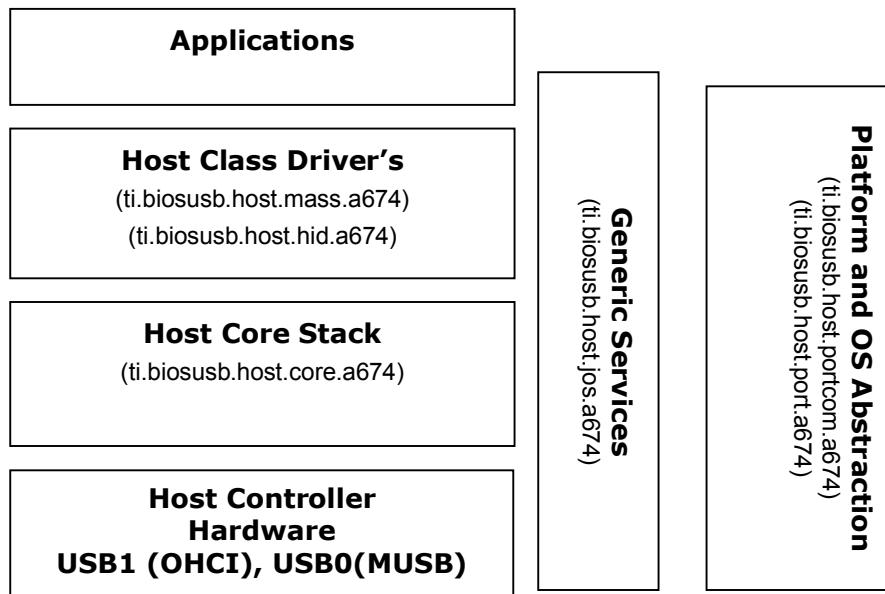
**Folder structure - detailed.**

- A. **device**: This folder contains
  - a. Public header files relating to the device stack
  - b. Device stack libraries in **release** mode in for C6747/C6748 platforms. All the libraries will have a platform specific extension.
- B. **host**: This folder contains
  - a. Public header files relating to the host stack
  - b. Host stack libraries in **release** mode for C6747/C6748 platforms. All the libraries will have a platform specific extension.
- C. **apps** : This folder contains the USB application for device/host.
  - a. **devmscglue** This folder contains the USB device MSC glue application source, documentation and binary (Debug and Release modes). MSC glue application supports storage device exposition over USB (Platform acting as MSC device to a USB host).
- D. **example** : This folder contains the example for USB device or host for C6747/C6748 platforms.
- E. **Header Files** : The exported header files are distributed in following directory.
  - a. <BIOSUSB\_INSTALL\_DIR>\packages\ti\biosusb
  - b. <BIOSUSB\_INSTALL\_DIR>\packages\ti\biosusb\host
  - c. <BIOSUSB\_INSTALL\_DIR>\packages\ti\biosusb\device

For example the USB host Driver Interface prototype definitions (USBDI API) are available in biosusb\host\usbdi.h. Please refer documents in section 1.2 for more information.

## 4 USB Host Stack Architecture

The USB host stack provides capability to support hot-pluggable interfaces for connecting various USB devices. Figure 2 illustrates the architecture of the USB host stack. Sections 3.1 to 3.9 describe the functionality of each of the components in the USB host architecture. Host stack component libraries are located in biosusb\host\Release folder.



**Figure 2:** USB Host Stack Architecture

### 4.1 Host Core Stack

The host core stack component (`ti.biosusb.host.core.a674`) provides an implementation of the USB host functionality. It provides communication facility to its clients (class drivers) such as the mass storage class driver. This component also implements the hub driver and the host controller driver functionality for both USB1.1 Host Controller (OHCI) and USB2.0 controller (MUSB).

### 4.2 Host Class (MSC) Driver

The host mass storage class driver component (`ti.biosusb.host.mass.a674`) provides the capability to communicate with external USB mass storage devices such as thumb drives. It supports the SCSI command protocol for communication with the external USB mass storage devices.

### 4.3 Host Class (HID) Driver

The HID class driver component (`ti.biosusb.host.hid.a674`) provides the support for HID input devices like keyboard, mouse etc

## 4.4 Host Generic Services

The USB host generic services component (ti.biosusb.host.jos.a674) provides the services to the other components in the USB host stack architecture. It provides services for memory allocation, task management and initialization.

## 4.5 Platform Abstraction and Native OS Abstraction

The platform abstraction and native OS abstraction provides abstraction to the platform features and operating system interfaces. This component provides isolation to the other components of the host stack architecture from platform, native operating system and allows portability of the host stack components.

## 4.6 Host Stack Component Libraries and Dependencies

Table 1 lists the host stack components and the corresponding libraries included in the BIOSUSB deliverable. Note: The host stack component libraries are located at biosusb\host.

Host Stack Component	Library Name	Depends On
Host Core Stack	ti.biosusb.host.core.a674	ti.biosusb.host.jos.a674
Host MSC Class Driver	ti.biosusb.host.mass.a674	ti.biosusb.host.core.a674 ti.biosusb.host.jos.a674
Host HID Class Driver	ti.biosusb.host.hid.a674	ti.biosusb.host.core.a674 ti.biosusb.host.jos.a674
Host Generic Services	ti.biosusb.host.jos.a674	ti.biosusb.host.portcom.a674 ti.biosusb.host.port.a674
Platform and Native OS Abstraction	ti.biosusb.host.portcom.a674 ti.biosusb.host.port.a674	None

**Table 1:** USB Host Stack Component Libraries and Dependency

## 4.7 Host Stack Component Build Options

Multiple build options can be specified for the compilation of the USB host stack components. Table 2 lists the build options that have been used to build the (binary) host stack components that are available in the BIOS USB package.

#	Configuration Option	Configuration Value
1	CONFIG_PORT	dsp_bios
2	CONFIG_MEMPOOL	1

3	CONFIG_MEMPOOL_SIZE	500000
4	CONFIG_MEMPOOL_DMABLE	1
5	CONFIG_MUSBHSHC	1
6	CONFIG_JHOST	1
7	CONFIG_BYTE_ORDER	CPU_LITTLE_ENDIAN
8	CONFIG_ALIGN_CRITICAL	1
9	CONFIG_EXTERNAL_VBUS_CONTROL	1
10	CONFIG_LONG_64B	1
11	CONFIG_EXTERNAL_DMA	1

**Table 2:** USB Host Stack Component Build Options

#### 4.8 Platform specific library

The usb platform specific library support of platform specific initialization for usb module for C6747/C6748 platforms.

#### 4.9 Use Case: USB Host Mass Storage Functionality

The following libraries are required to build a USB host mass storage functionality. These libraries are available in Release mode in the directory biosusb/host/Release.

- A. ti.biosusb.host.core.a674
- B. ti.biosusb.host.mass.a674
- C. ti.biosusb.host.jos.a674
- D. ti.biosusb.host.portcom.a674
- E. ti.biosusb.host.port.a674

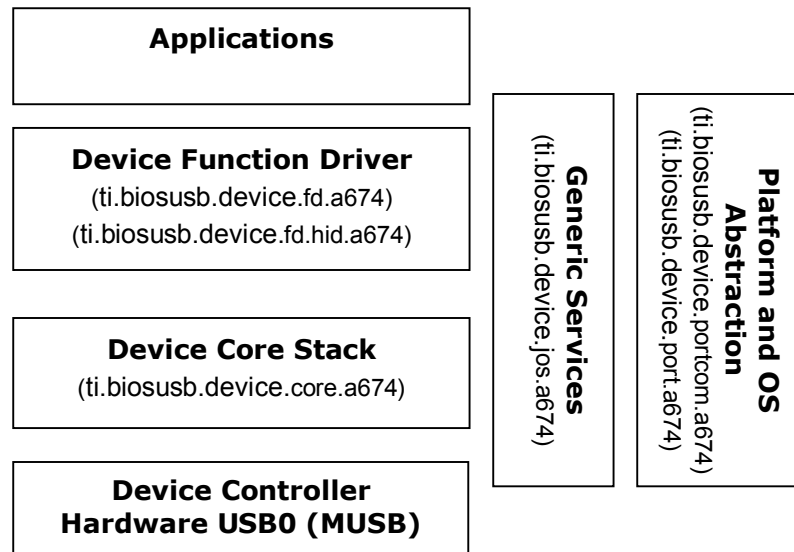
#### 4.10 Use Case: USB Host HID Functionality

The following libraries are required to build a USB host HID functionality. These libraries are available for both in Debug and Release mode in the directory biosusb/host/Release.

- F. ti.biosusb.host.core.a674
- G. ti.biosusb.host.jos.a674
- H. ti.biosusb.host.portcom.a674
- I. ti.biosusb.host.port.a674
- J. ti.biosusb.host.hid.a674

## 5 USB Device Stack Architecture

The USB device stack enables the platform to act as a USB device to a USB host. Figure 3 illustrates the architecture of the USB device stack. Sections 5.1 to 5.7 describes the functionality of each of the components in the USB device architecture.



**Figure 3:** USB Device Stack Architecture

### 5.1 Device Core Stack

The device core stack (`ti.biosusb.device.core.a674`) component provides an implementation of the USB device functionality and device controller driver for USB2.0 MUSB controller. It provides communication facility to its clients (Class function drivers) such as the mass storage function driver.

### 5.2 Device (MSC) Function Driver

The device mass storage function driver component provides the capability to expose mass storage device functionality to the USB host. It supports the SCSI command protocol for communication with the USB host.

### 5.3 Device (HID) Function Driver

The HID function driver component provides the capability to expose HID device interface functionality to the USB host.

### 5.4 Device Generic Services

The USB device generic services component provides the services to the other components in the USB device stack architecture. It provides services for memory allocation, task management and initialization.

## 5.5 Platform Abstraction and Native OS Abstraction

The platform abstraction and native OS abstraction provides abstraction to the platform features and operating system interfaces. This component provides isolation to the other components of the device stack architecture from platform and native operating system and allows portability of the device stack components.

## 5.6 Device Stack Component Libraries and Dependencies

Table 3 lists the device stack components and the corresponding libraries included in the PSP deliverable.

Host Stack Component	Library Name	Depends On
Device Core Stack	ti.biosusb.device.core.a674	ti.biosusb.device.jos.a674 ti.biosusb.device.port.a674
Device MSC/HID Function Driver	ti.biosusb.device.fd.a674/ ti.biosusb.device.fd.hid.a674	ti.biosusb.device.core.a674 ti.biosusb.device.jos.a674
Device Generic Services	ti.biosusb.device.jos.a674	ti.biosusb.device.port.a674 ti.biosusb.device.portcom.a674
Platform and Native OS Abstraction	ti.biosusb.device.port.a674 ti.biosusb.device.portcom.a674	None

**Table 3:** USB Device Stack Component Libraries and Dependency

## 5.7 Device Stack Component Build Options

Multiple build options can be specified for compilation of the USB device stack components. Table 4 lists the build options that have been used to build the device stack components that are available in the BIOS USB product.

#	Configuration Option	Configuration Value
1	CONFIG_PORT	Dsp_bios
2	CONFIG_MEMPOOL	1
3	CONFIG_MEMPOOL_SIZE	500000
4	CONFIG_MEMPOOL_DMABLE	1
5	CONFIG_MUSBHSC	1
6	CONFIG_JSLAVE	1
7	CONFIG_BYTE_ORDER	CPU_LITTLE_ENDIAN
8	CONFIG_ALIGN_CRITICAL	1
9	CONFIG_EXTERNAL_VBUS_CONTROL	1



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10	CONFIG_LONG_64B	1
11	CONFIG_EXTERNAL_DMA	1

**Table 4:** USB Device Stack Component Build Options

## 5.8 Use Case: USB Device Mass Storage Functionality

The following libraries are required to build USB device mass storage functionality. These libraries are available in Release mode in the directory biosusb/device/Release.

- A. ti.biosusb.device.core.a674
- B. ti.biosusb.device.fd.a674
- C. ti.biosusb.device.jos.a674
- D. ti.biosusb.device.port.a674
- E. ti.biosusb.device.portcom.a674

## 5.9 Use Case: USB Device HID Functionality

The following libraries are required to build USB device HID function driver . These libraries are available in Release mode in the directory biosusb/device/Release.

- A. ti.biosusb.device.core.a674
- B. ti.biosusb.device.jos.a674
- C. ti.biosusb.device.port.a674
- D. ti.biosusb.device.portcom.a674
- E. ti.biosusb.device.fd.hid.a674

## 6 Building and Running USB Application Example

This chapter discusses how to configure and run the USB host or device example provided along with the package.

**Note :** Before running any USB example, user should perform system reset or reset the target board or EVM . The system reset can be performed through code composer studio IDE. (From CCS IDE, select menu item Debug->"Advanced Resets"->"System Reset"). Note that CPU Reset from CCS does only the resetting the CPU, it does not reset the entire system.

### Setup Procedure for CCS4 Environment ( Building and Loading the executable)

1. Invoke the CCS4 and perform Target configuration to configure C6747/OMAPL137 or C6748/OMAPL138 EVM platform and use the appropriate DSP gel file and Launch the target by selecting Debug-> "TI Launch Debugger", then connect to the target.
2. Select C/C++ perspective window (click on window->"open perspective"->C/C++) and Open the USB example's appropriate CCS4 project file. Select Project->"Import existing CCS/CCSE eclipse project" and provide project directory path from "<INSTALL\_DIR> \biosusb\_xx\_yy\_zz\ packages\ ti\ biosusb\ examples\ <usbdevmsc, usbdevhid, usbhostid >\build\ <C6747/ C6748>\ ccs4". This will load the selected project. Set Project configuration to Debug/Release mode.
3. Build the project in Release/Debug mode. Switch to Debug window by selecting Debug Perspective window (click on window->"open perspective"->Debug) and load the executable.
4. Run the application program by pressing F8 key.

### 6.1 Building the USB MSC Device example for NAND OR MMC/SD OR SATA.

Below steps details how to build the USB device mass-storage application, where the target platform acts as USB mass-storage device with NAND or MMC/SD or SATA (only on C6748/OMAPL138 platform) as local storage media. User can choose the storage media to be either NAND or MMCSD or SATA with this application. Make sure all the dependent packages/components are installed and the environment variables are created and the values are initialized correctly.

#### For CCS3 Environment

1. Setup the CCSV3 to configure C6747/OMAPL137 or C6748/OMAPL138 EVM platform and use the appropriate DSP gel file and connect to the target.
2. Open the project (PJT file) for the USB device sample application from "<INSTALL\_DIR>\biosusb\_xx\_yy\_zz\packages\ti\biosusb\examples\usbdevmsc\build\<C6747/C6748>\ccs3\usb\_dev\_msc\_sample.pjt". Set Project configuration to Release mode.
3. User can chose either NAND or MMC/SD or SATA (only C6748 paltform) as storage media. Refer to block media user guide from BIOSPSP package for further details with respect to media selection to expose over USB.

4. Build the project in Release mode, the executable file will be created in the "`<INSTALL_DIR>\biosusb_xx_yy_zz\packages\ti\biosusb\examples\usbdevmsc\build\<C6747/C6748>\ccs3\bin\<Debug or Release>`" folder.
5. Load the '`devmsc_sample.out`' file from the Release folder to target and Run.

#### For CCS4 Environment

Please follow the procedure explained in section 6.

6. Connect the micro-B USB cable between the target (USB0 port) and Host PC. The PC enumerates the mass storage device and new removable drive will be appear in the explorer.
7. Format the drive, now the device is ready for file read/write operation.

## **6.2 Building the USB HID (keyboard) Device example.**

Below steps details how to build the USB device HID application, where the target platform acts HID Keyboard device. Make sure all the dependent packages/components are installed and the environment variables are created and the values are initialized correctly.

#### For CCS3 Environment

1. Setup the CCSV3 to configure C6747/OMAPL137 or C6748/OMAPL138 EVM platform and use the appropriate DSP gel file and connect to the target.
2. Open the project (PJT file) for the USB HID device sample application from "`<INSTALL_DIR>\biosusb_xx_yy_zz\packages\ti\biosusb\examples\usbdevhid\build\<C6747/C6748>\ccs3\usb_dev_hid_sample.pjt`". Set Project configuration to Release mode.
3. Build the project in Release mode, the executable file will be created in the "`<INSTALL_DIR>\biosusb_xx_yy_zz\packages\ti\biosusb\examples\usbdevhid\build\<C6747/C6748>\bin\Release`" folder.
4. Load the '`devhid_sample.out`' file from the Release folder to target and Run.

#### For CCS4 Environment

Please follow the procedure explained in section 6.

5. Connect the micro-B USB cable between the target (USB0 port) and host-pc. The PC enumerates the HID device.

**Note :** In this example, in order to simulate the key press events, open the Notepad application in host-pc. Press "Shift" key and "Scroll lock" key together from the host-pc keyboard, you will see the "Jungo Demo!" string displayed on the notepad.

## **6.3 Building the USB Host Mass Storage example.**

This example will details how to build the USB host mass-storage application. Please refer section 3.8.4 in RTFS User's Guide. The section 3.8.4 of RTFS User's guide will explain how to configure and build this example and its usage.

**Note:** This example dependent on the block media with RTFS file system support. The block media file system project from the PSP\_DRIVERS packages needs to be built. Refer the block media documentation for further information.

---

## **6.4 Building the USB Host HID (keyboard/mouse) example.**

Below steps details how to build the USB host HID example application.

### For CCS3 Environment

1. Setup the CCSV3 to configure C6747/OMAPL137 or C6748/OMAPL138 EVM platform and use the appropriate DSP gel file and connect to the target.
2. Open the project (PJT file) for the USB host sample HID application from "`<INSTALL_DIR>\biosusb_xx_yy_zz\packages\ti\biosusb\examples\usbhosthid\build\<C6747/C6748>\ccs3\usb_host_hid_sample.pjt`". Set Project configuration to Release mode.
3. Build the project in Release mode, the executable file will be created in the "`<INSTALL_DIR>\biosusb_xx_yy_zz\packages\ti\biosusb\examples\usbhosthid\build\<C6747/C6748>\bin\Release`" folder.
4. Connect the USB mouse/keyboard to USB port (USB0 or USB1) directly or through HUB.
5. Load the 'hosthid\_sample.out' file from the Release folder to target and Run.

### For CCS4 Environment

Please follow the procedure explained in section 6.

6. The target will enumerate the USB mouse/keyboard device, when you move mouse or press any key on keyboard, keyboard/mouse key press event message will be displayed on the console window.

## **7 Technical Support BIOSUSB**

To submit questions about issues with this BIOSUSB drivers release please go to the external forums at <http://community.ti.com/> or to <http://support.ti.com>