CE215121 - BLE HID Keyboard with PSoC 6 MCU with BLE Connectivity

Objective

This example demonstrates the implementation of the Bluetooth Low Energy (BLE) HID over GATT Profile where the device operates as a HID keyboard.

Overview

The design demonstrates the core functionality of the BLE Component configured as a HID Device (GATT Server). It simulates keyboard press in Boot and Protocol modes. Also, the design demonstrates how to handle a suspend event from the central device and enter Low-Power mode when suspended.

Requirements

Tool: PSoC Creator™ 4.2 or later

Programming Language: C (Arm® GCC 5.4-2016-q2-update or later)

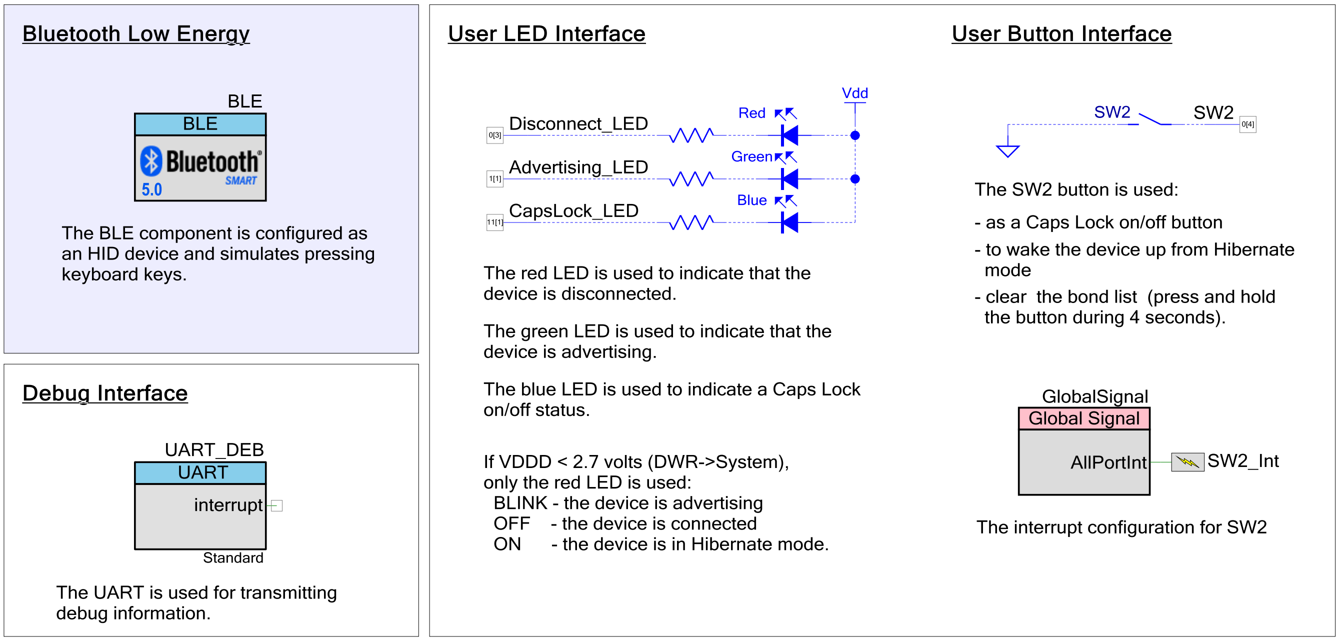
Associated Parts: All PSoC® 6 MCU with BLE Connectivity (PSoC 6 BLE) parts

Related Hardware: CY8CKIT-062 PSoC 6 BLE Pioneer Kit

Design

Figure 1 shows the top design schematic.

Figure 1. BLE HID Keyboard Code-Example Schematic



The BLE component is configured as an HID device and simulates pressing keyboard keys.

The UART is used for transmitting debug information.

The red LED is used to indicate that the device is disconnected.

The green LED is used to indicate that the device is advertising.

The blue LED is used to indicate a Caps Lock on/off status.

If VDDD < 2.7 volts (DWR->System), only the red LED is used:
BLINK - the device is advertising
OFF - the device is connected
ON - the device is in Hibernate mode.

The SW2 button is used:

- as a Caps Lock on/off button
- to wake the device up from Hibernate mode
- clear the bond list (press and hold the button during 4 seconds).

The interrupt configuration for SW2

The BLE Component implements a HID over the GATT Profile in the HID Device role (GATT Server).

After a start, the device performs the BLE Component initialization. The four callback functions are required in this project for the BLE operation:

- `AppCallBack()` is required to receive generic events from the BLE Stack.
- `HidsCallBack()`, `BasCallBack()`, and `ScpsCallBack()` are required to receive events from the services.

The `CY_BLE_GAPP_StartAdvertisement()` function is called after the `CY_BLE_EVT_STACK_ON` event to start advertising with the packet shown in Figure 7. As the BLE Component is configured in the General Discovery mode, it stops advertising after an advertisement period expires. On an advertisement timeout, the system enters Hibernate mode. Press the mechanical button **SW2** on the PSoC 6 BLE Pioneer Kit to wake up the system and start advertising. The BLE subsystem and CPU enter Low-Power Deep Sleep mode between the connection and advertising intervals. The BLE subsystem automatically wakes up to maintain connection and advertise data transfer.

The green LED blinks to indicate that the device is advertising. The red LED turns ON after disconnection to indicate that no client is connected to the device. When a client is connected successfully, the red and blue LEDs turn OFF. The blue LED indicates the Caps Lock state sent from the host through an output keyboard report characteristic.

Additionally, this project implements the Battery Service. By default, the battery level is simulated and changed from 2 to 20 percent.

Design Considerations

Using UART for Debugging

Download and install a serial port communication program. Freeware such as Bray's Terminal and PuTTY are available on the web.

1. Connect the PC and kit with a USB cable.
2. Open the device manager program in your PC, find a COM port that the kit is connected to, and note the port number.
3. Open the serial port communication program and select the previously noted COM port.
4. Configure the Baud rate, Parity, Stop bits, and Flow control information in the PuTTY configuration window. The default settings: Baud rate – 115200, Parity – None, Stop bits – 1, Flow control – XON/XOFF. These settings must match the configuration of the PSoC Creator UART component in the project.
5. Start communicating with the device as explained in the Operation section.

The UART debugging can be disabled by setting the `DEBUG_UART_ENABLED` to `DISABLED` in the *common.h* file.

LED Behavior for V_{DDD} Voltage < 2.7 V

If the V_{DDD} voltage is set to less than 2.7 V in the DWR settings of the **System** tab, only the red LED is used. The red LED blinks to indicate that the device is advertising. The red LED is OFF when the device is connected to a peer device. When the device is in Hibernate mode, the red LED stays ON.

Switching the CPU Cores Usage

This section describes how to switch between different CPU cores usage (Single core and Dual core) in the BLE Peripheral Driver Library (PDL) examples.

The BLE Component has the CPU Core parameter that defines the cores usage. It can take the following values:

- **Single core (Complete Component on CM0+)** – only CM0+ core will be used.
- **Single core (Complete Component on CM4)** – only CM4 core will be used.
- **Dual core (Controller on CM0+, Host and Profiles on CM4)** – both cores will be used: CM0+ for the Controller and CM4 for the Host and Profiles.

The BLE examples' structure allows easy switching between different CPU cores options.

Important to remember:

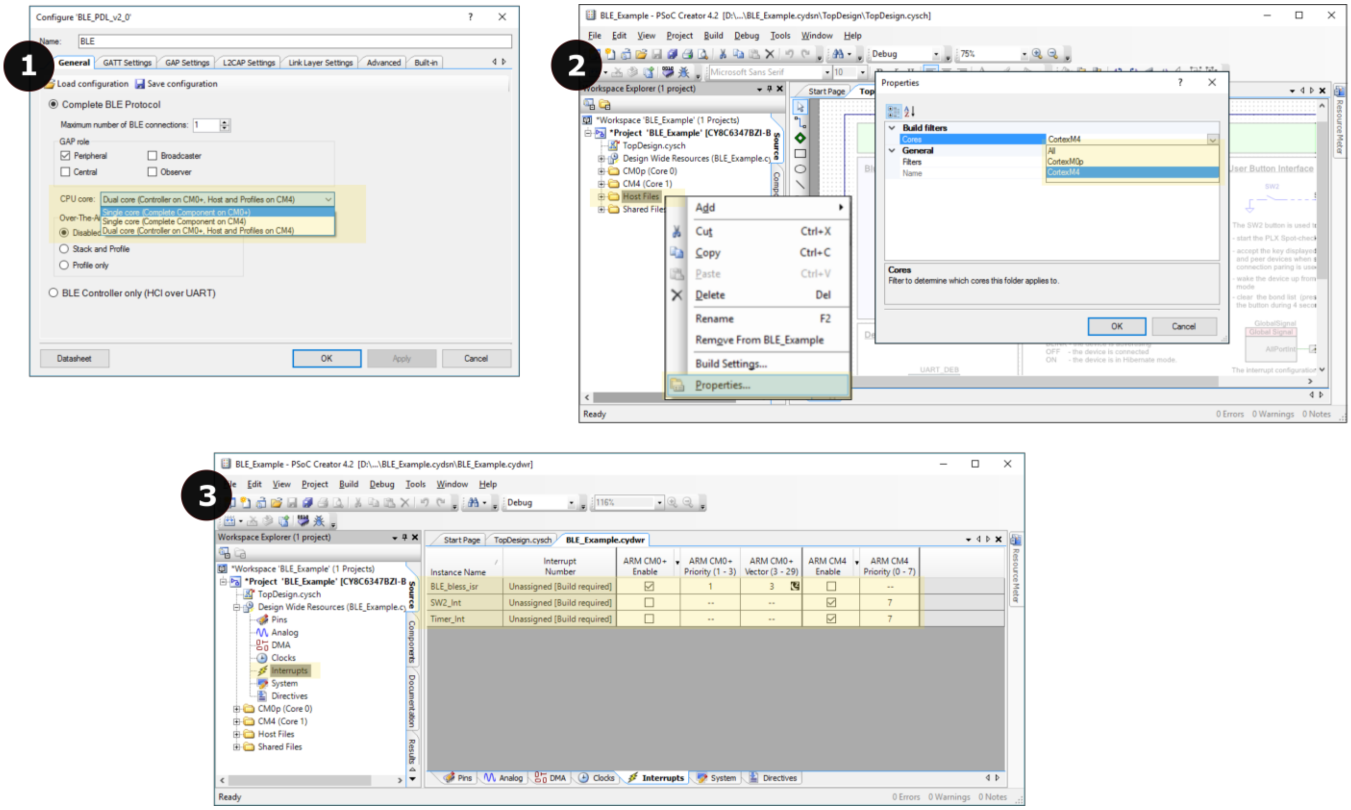
- All application host-files must be run on the host core.
- The BLE Subsystem (BLESS) interrupt must be assigned to the core where the controller runs.
- All additional interrupts (SW2, MCWDT, etc.) used in the example must be assigned to the host core.

Do the following to switch the CPU cores usage:

1. In the BLE Component Customizer **General** tab, select appropriate CPU core option.

2. Change the core properties to CortexM4 or CortexC0p for the project folder Host Files based on the CPU core option selected in step 1. It should be:
   - For **Single core (Complete Component on CM0+)** option: CM0+
   - For **Single core (Complete Component on CM4)** option: CM4
   - For **Dual core (Controller on CM0+, Host and Profiles on CM4)** option: CM4
3. Assign the BLE_bless_isr and other peripheral (button – SW2, timer(s) etc.) interrupts to appropriate core in **DWR** > **Interrupts** tab:
   - For **Single core (Complete Component on CM0+)** option: BLE_bless_isr and peripheral interrupts on **CM0+**
   - For **Single core (Complete Component on CM4)** option: BLE_bless_isr and peripheral interrupts on **CM4**
   - For **Dual core (Controller on CM0+, Host and Profiles on CM4)** option: BLE_bless_isr interrupt on **CM0+,** other peripheral interrupts on **CM4**

Figure 2. Steps for Switching the CPU Cores Usage



Name: BLE

● Complete BLE Protocol

Maximum number of BLE connections: 1

GAP role

☑ Peripheral ☐ Broadcaster

☐ Central ☐ Observer

CPU core: Dual core (Controller on CM0+, Host and Profiles on CM4)

Single core (Complete Component on CM0+)
Single core (Complete Component on CM4)
Dual core (Controller on CM0+, Host and Profiles on CM4)

Over-The-Air

● Disabled

○ Stack and Profile

○ Profile only

○ BLE Controller only (HCI over UART)

Build filters

Cores: CortexM4 (All / CortexM0p / CortexM4)

General

Filters

Name

Cores
Filter to determine which cores this folder applies to.

Instance Name	Interrupt Number	ARM CM0+ Enable	ARM CM0+ Priority (1 - 3)	ARM CM0+ Vector (3 - 29)	ARM CM4 Enable	ARM CM4 Priority (0 - 7)
BLE_bless_isr	Unassigned [Build required]	☑	1	3	☐	--
SW2_Int	Unassigned [Build required]	☐	--	--	☑	7
Timer_Int	Unassigned [Build required]	☐	--	--	☑	7

Hardware Setup

The code example was created for the CY8CKIT-062 PSoC 6 BLE Pioneer Kit.

Table 1. The pin assignment and connections required on the development board for the supported kits.

Table 1. Pin Assignment

Pin Name	Development Kit	Comment
	CY8CKIT-062	
\UART_DEB:rx\	P5[0]	
\UART_DEB:tx\	P5[1]	
\UART_DEB:rts\	P5[2]	
\UART_DEB:cts\	P5[3]	
Advertising_LED	P1[1]	The green color of the RGB LED
Disconnect_LED	P0[3]	The red color of the RGB LED
CapsLock_LED	P11[1]	The blue color of the RGB LED
SW2	P0[4]	

Components

Table 2 lists the PSoC Creator Components used in this example and the hardware resources used by each of the components.

Table 2. PSoC Creator Components List

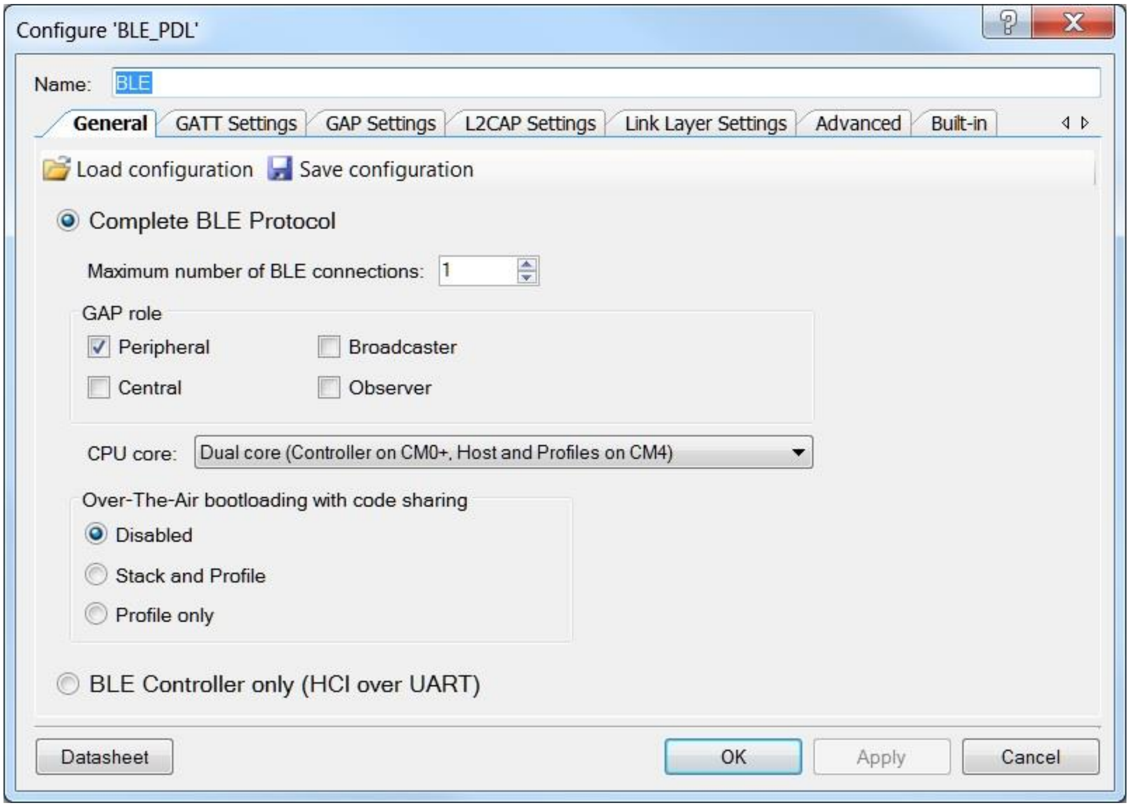
Component	Hardware Resources
BLE	1 BLE, 1 Interrupt
UART_DEB	1 SCB
SW2	1 pin
Wakeup_Interrupt	1 interrupt
Disconnect_LED, Advertising_LED, CapsLock_LED	3 pins

Parameter Settings

Bluetooth Low Energy (BLE)

The BLE Component is configured as a HID over a GATT Profile in the HID device role (GATT Server). The HID Device has one instance of the HID Service, Battery Service, Device Information Service, and Scan Parameters Service.

Figure 3. General Settings



Configure 'BLE_PDL'

Name: BLE

● Complete BLE Protocol

Maximum number of BLE connections: 1

GAP role

☑ Peripheral ☐ Broadcaster

☐ Central ☐ Observer

CPU core: Dual core (Controller on CM0+, Host and Profiles on CM4)

Over-The-Air bootloading with code sharing

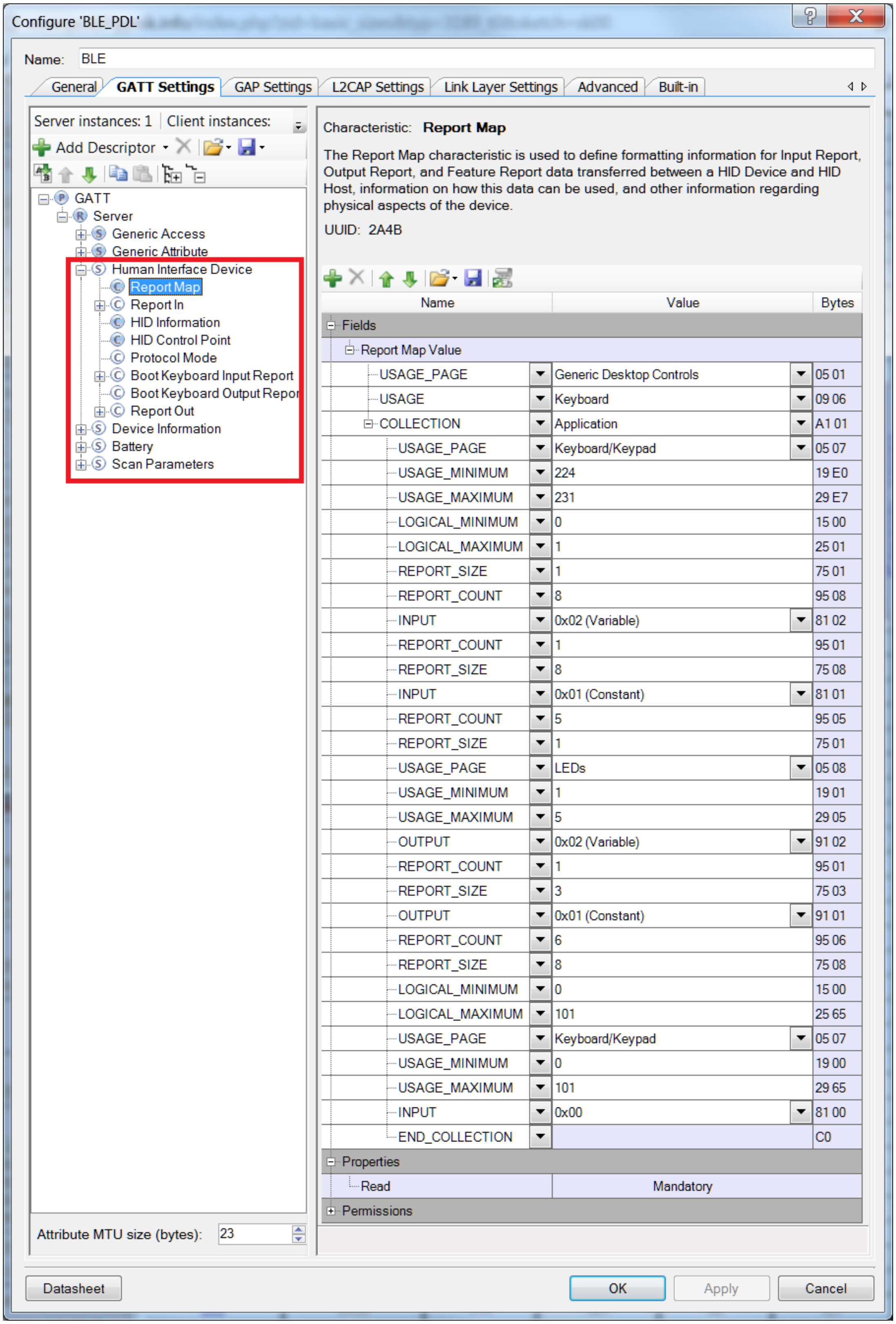
● Disabled

○ Stack and Profile

○ Profile only

○ BLE Controller only (HCI over UART)

Figure 4. GATT Settings



Name: BLE

Server instances: 1 | Client instances:

Characteristic: **Report Map**

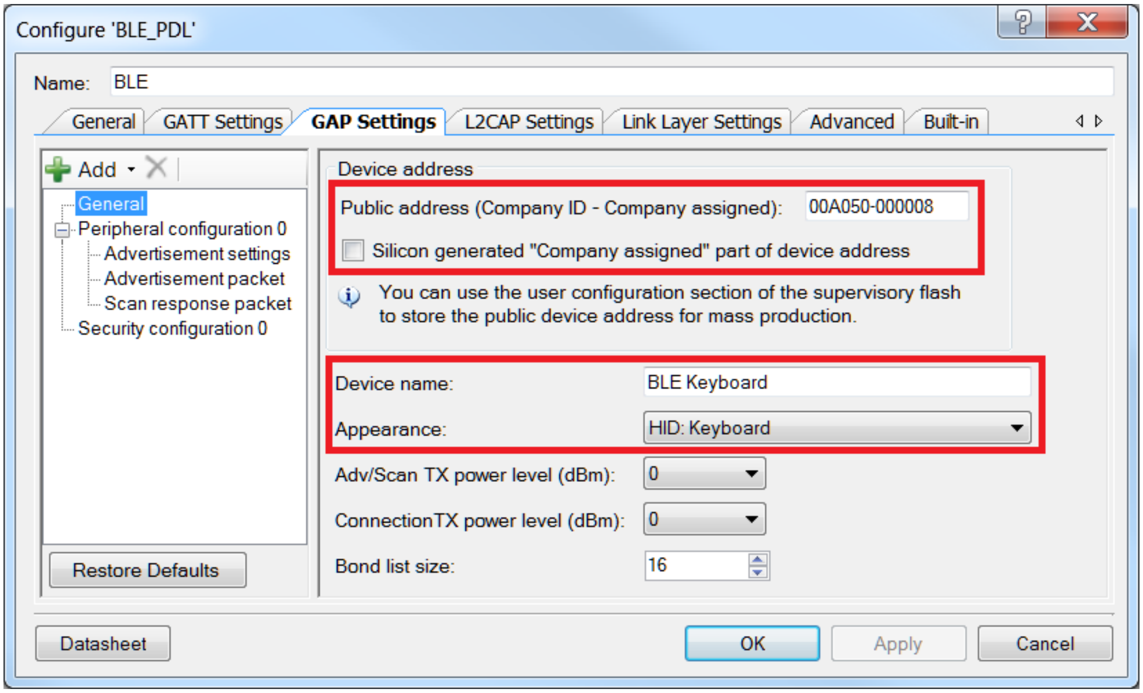
The Report Map characteristic is used to define formatting information for Input Report, Output Report, and Feature Report data transferred between a HID Device and HID Host, information on how this data can be used, and other information regarding physical aspects of the device.

UUID: 2A4B

Name	Value	Bytes
Fields		
Report Map Value		
USAGE_PAGE	Generic Desktop Controls	05 01
USAGE	Keyboard	09 06
COLLECTION	Application	A1 01
USAGE_PAGE	Keyboard/Keypad	05 07
USAGE_MINIMUM	224	19 E0
USAGE_MAXIMUM	231	29 E7
LOGICAL_MINIMUM	0	15 00
LOGICAL_MAXIMUM	1	25 01
REPORT_SIZE	1	75 01
REPORT_COUNT	8	95 08
INPUT	0x02 (Variable)	81 02
REPORT_COUNT	1	95 01
REPORT_SIZE	8	75 08
INPUT	0x01 (Constant)	81 01
REPORT_COUNT	5	95 05
REPORT_SIZE	1	75 01
USAGE_PAGE	LEDs	05 08
USAGE_MINIMUM	1	19 01
USAGE_MAXIMUM	5	29 05
OUTPUT	0x02 (Variable)	91 02
REPORT_COUNT	1	95 01
REPORT_SIZE	3	75 03
OUTPUT	0x01 (Constant)	91 01
REPORT_COUNT	6	95 06
REPORT_SIZE	8	75 08
LOGICAL_MINIMUM	0	15 00
LOGICAL_MAXIMUM	101	25 65
USAGE_PAGE	Keyboard/Keypad	05 07
USAGE_MINIMUM	0	19 00
USAGE_MAXIMUM	101	29 65
INPUT	0x00	81 00
END_COLLECTION		C0
Properties		
Read	Mandatory	
Permissions		

Attribute MTU size (bytes): 23

Figure 5. GAP Settings



Name: BLE

Device address

Public address (Company ID - Company assigned): 00A050-000008

□ Silicon generated "Company assigned" part of device address

You can use the user configuration section of the supervisory flash to store the public device address for mass production.

Device name: BLE Keyboard

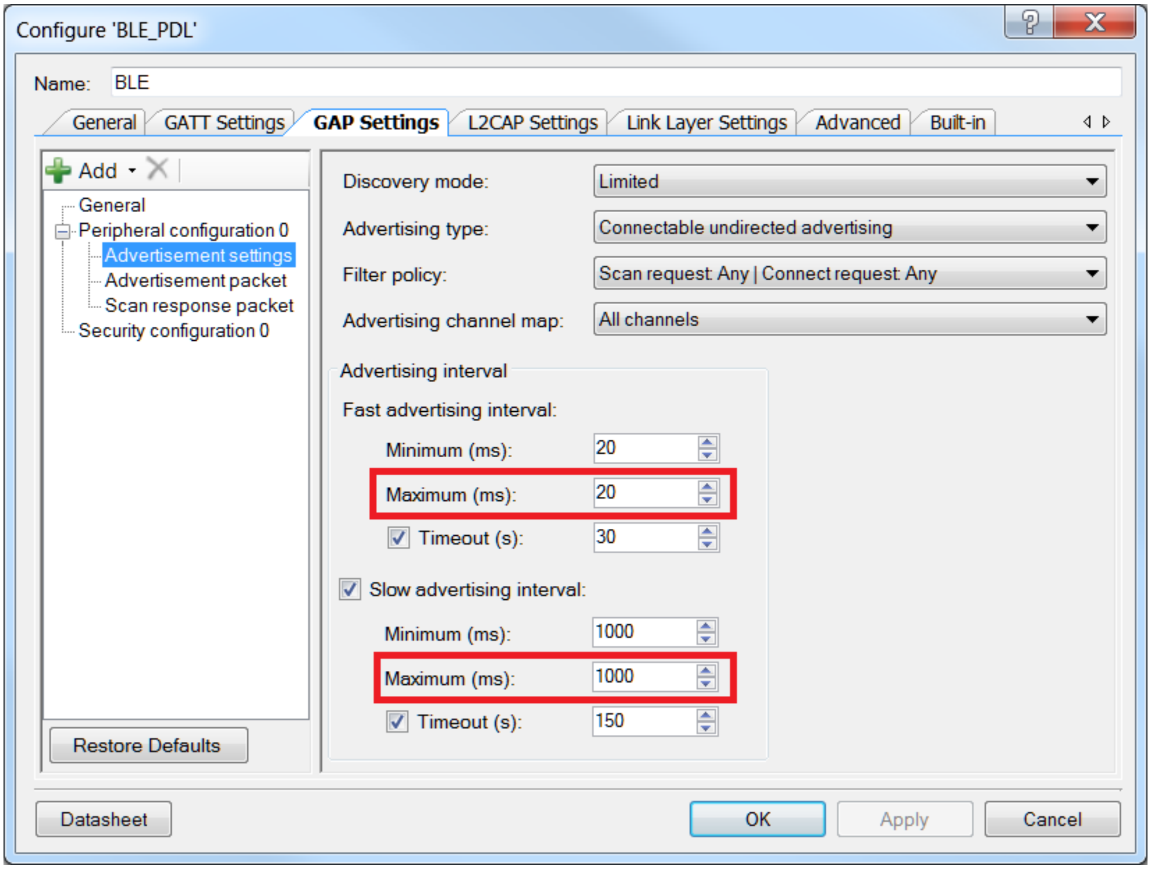
Appearance: HID: Keyboard

Adv/Scan TX power level (dBm): 0

ConnectionTX power level (dBm): 0

Bond list size: 16

Figure 6. GAP Settings: Advertisement Settings



Name: BLE

Discovery mode: Limited

Advertising type: Connectable undirected advertising

Filter policy: Scan request: Any | Connect request: Any

Advertising channel map: All channels

Advertising interval

Fast advertising interval:

Minimum (ms): 20

Maximum (ms): 20

☑ Timeout (s): 30

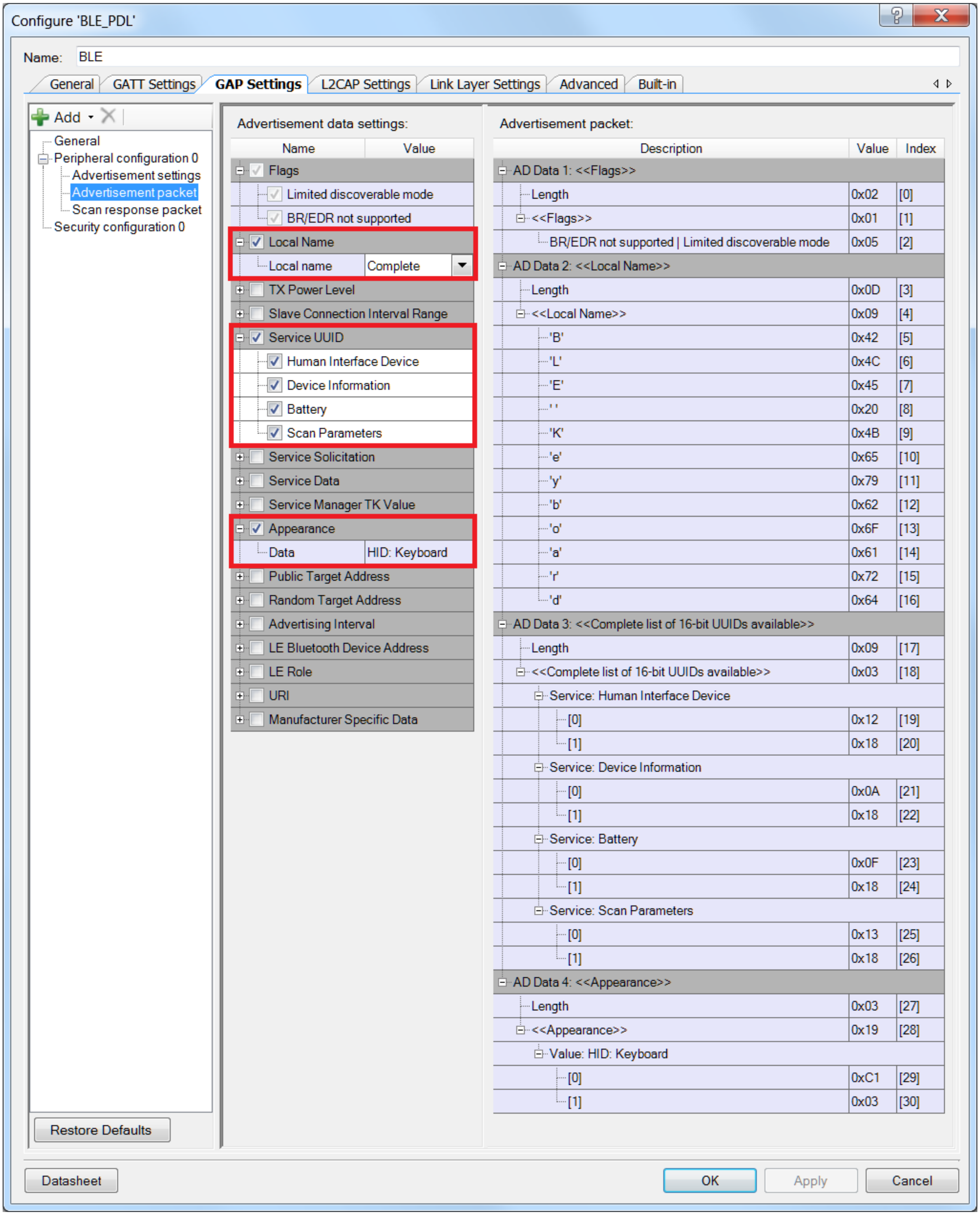
☑ Slow advertising interval:

Minimum (ms): 1000

Maximum (ms): 1000

☑ Timeout (s): 150

Figure 7. GAP Settings: Advertisement Packet



Name: BLE

- General
- Peripheral configuration 0
  - Advertisement settings
  - Advertisement packet
  - Scan response packet
- Security configuration 0

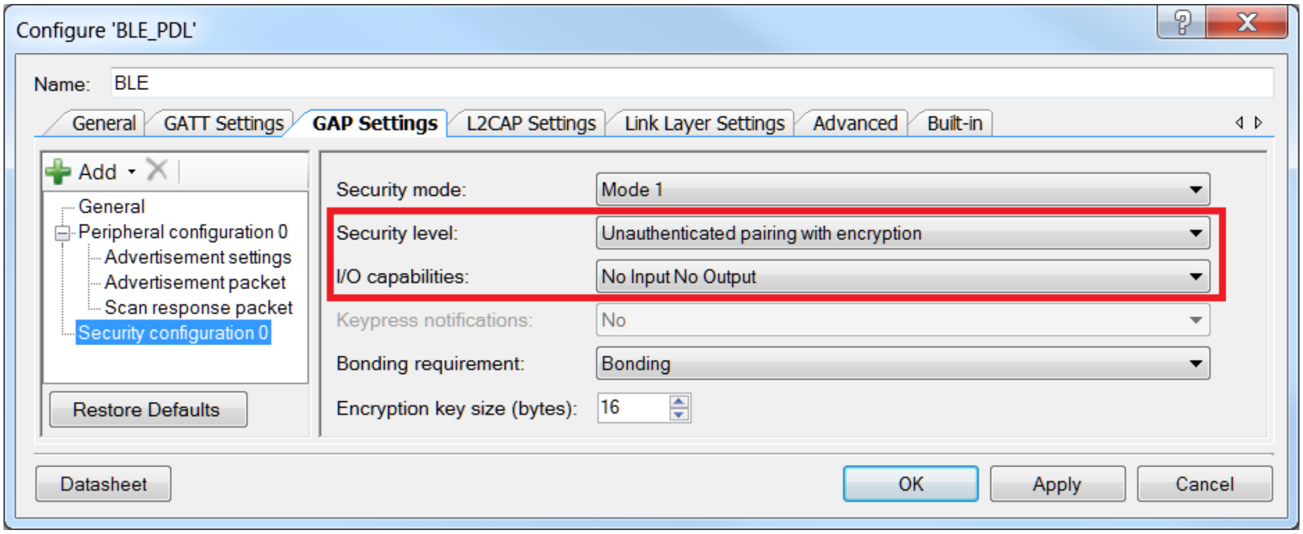
Advertisement data settings:

Name	Value
☑ Flags	
☑ Limited discoverable mode	
☑ BR/EDR not supported	
☑ Local Name	
Local name	Complete
□ TX Power Level	
□ Slave Connection Interval Range	
☑ Service UUID	
☑ Human Interface Device	
☑ Device Information	
☑ Battery	
☑ Scan Parameters	
□ Service Solicitation	
□ Service Data	
□ Service Manager TK Value	
☑ Appearance	
Data	HID: Keyboard
□ Public Target Address	
□ Random Target Address	
□ Advertising Interval	
□ LE Bluetooth Device Address	
□ LE Role	
□ URI	
□ Manufacturer Specific Data	

Advertisement packet:

Description	Value	Index
AD Data 1: <<Flags>>		
Length	0x02	[0]
<<Flags>>	0x01	[1]
BR/EDR not supported | Limited discoverable mode	0x05	[2]
AD Data 2: <<Local Name>>		
Length	0x0D	[3]
<<Local Name>>	0x09	[4]
'B'	0x42	[5]
'L'	0x4C	[6]
'E'	0x45	[7]
' '	0x20	[8]
'K'	0x4B	[9]
'e'	0x65	[10]
'y'	0x79	[11]
'b'	0x62	[12]
'o'	0x6F	[13]
'a'	0x61	[14]
'r'	0x72	[15]
'd'	0x64	[16]
AD Data 3: <<Complete list of 16-bit UUIDs available>>		
Length	0x09	[17]
<<Complete list of 16-bit UUIDs available>>	0x03	[18]
Service: Human Interface Device		
[0]	0x12	[19]
[1]	0x18	[20]
Service: Device Information		
[0]	0x0A	[21]
[1]	0x18	[22]
Service: Battery		
[0]	0x0F	[23]
[1]	0x18	[24]
Service: Scan Parameters		
[0]	0x13	[25]
[1]	0x18	[26]
AD Data 4: <<Appearance>>		
Length	0x03	[27]
<<Appearance>>	0x19	[28]
Value: HID: Keyboard		
[0]	0xC1	[29]
[1]	0x03	[30]

Figure 8. Security Settings



Name: BLE

Security mode: Mode 1

Security level: Unauthenticated pairing with encryption

I/O capabilities: No Input No Output

Keypress notifications: No

Bonding requirement: Bonding

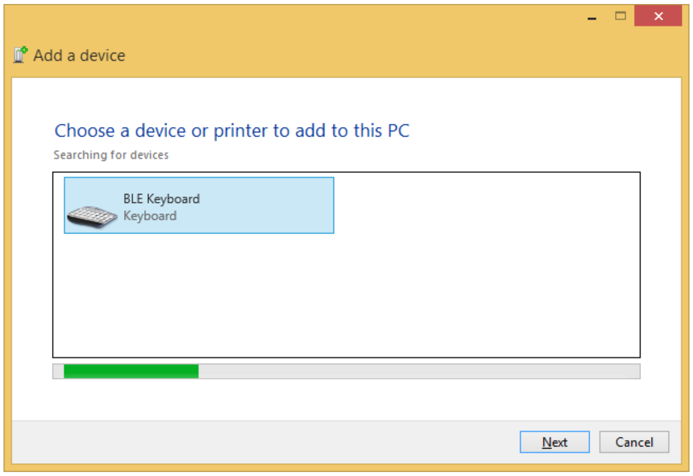
Encryption key size (bytes): 16

Operation

You can connect the HID Device to Windows 8. Windows 7 and older OS do not have HOGP drivers.

1. Make sure that a PC with Windows 8 has Bluetooth 4.0 installed.
2. To connect to a HID device, click **Add a device** in the **Devices and Printers** window of the Control Panel.
3. Select the **BLE Keyboard** device and click **Next**.

Figure 9. Pairing with Windows 8 PC



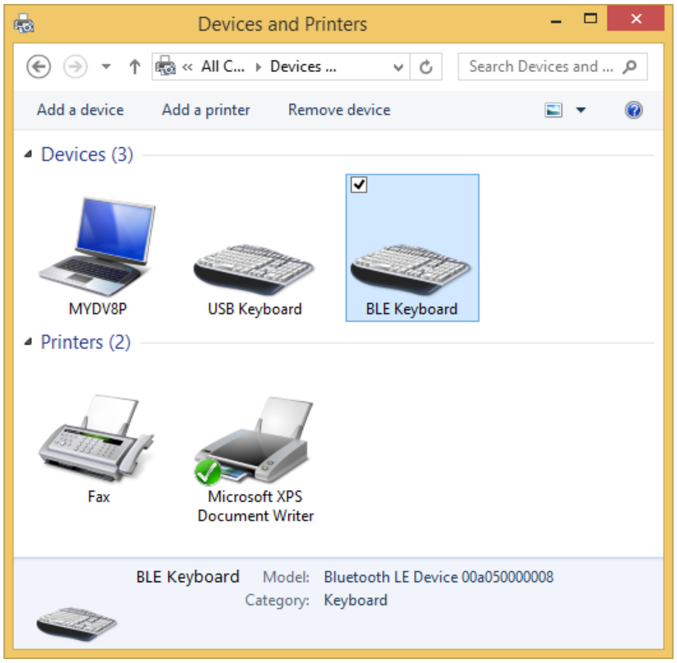
Choose a device or printer to add to this PC

Searching for devices

BLE Keyboard
Keyboard

The setup will automatically install the necessary files in the system.

Figure 10. BLE Keyboard is Recognized as HID Device

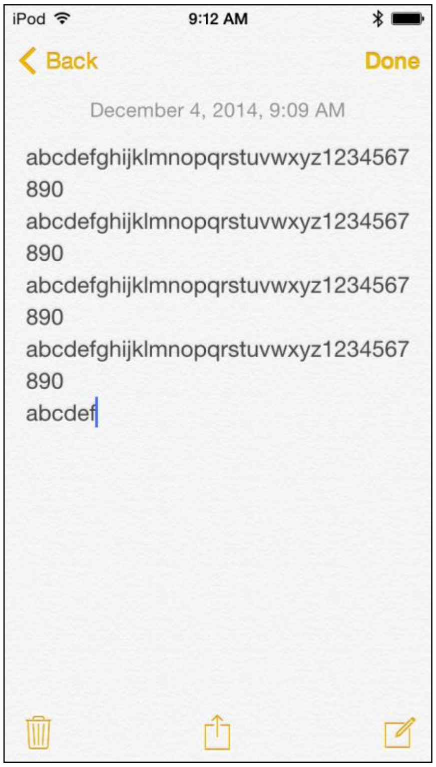


BLE Keyboard Model: Bluetooth LE Device 00a050000008
Category: Keyboard

4. Focus the input to an editable field (open text editor, take a note, and so on).
5. Observe that simulated keys “abcdef…” fill the document.
6. When **SW2** is pressed, the Caps Lock LED on the keyboard is turned ON/OFF. The blue LED on the kit indicates the Caps Lock state received from the HID Client.

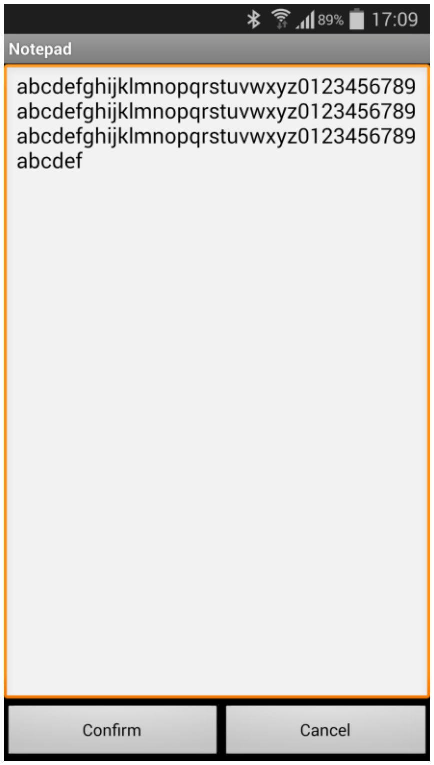
Note: Earlier versions of Android OS does not send a Caps Lock state back to the device, so the LED will not be turned ON/OFF.

Figure 11. HID Keyboard Emulation on iOS Device



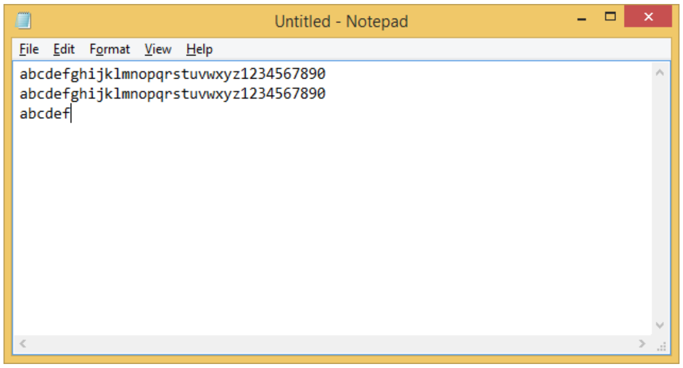
```
abcdefghijklmnopqrstuvwxyz1234567
890
abcdefghijklmnopqrstuvwxyz1234567
890
abcdefghijklmnopqrstuvwxyz1234567
890
abcdefghijklmnopqrstuvwxyz1234567
890
abcdef
```

Figure 12. HID Keyboard Emulation on Android Device



```
abcdefghijklmnopqrstuvwxyz0123456789
abcdefghijklmnopqrstuvwxyz0123456789
abcdefghijklmnopqrstuvwxyz0123456789
abcdef
```

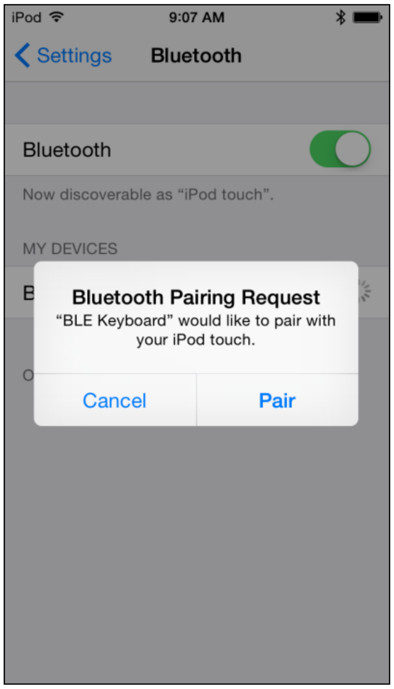
Figure 13. HID Keyboard Emulation on Windows 8 PC



```
abcdefghijklmnopqrstuvwxyz1234567890
abcdefghijklmnopqrstuvwxyz1234567890
abcdef
```

Also, you can connect a HID Device to an Android or iOS device with Bluetooth 4.0 support: go to the phone’s Bluetooth settings and pair it with your device (it should be recognized as BLE keyboard).

Figure 14. iOS Bluetooth Pairing



iPod 9:07 AM

Settings Bluetooth

Bluetooth

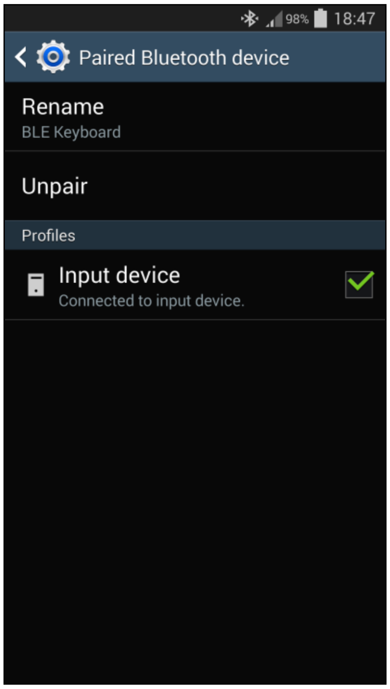
Now discoverable as “iPod touch”.

MY DEVICES

Bluetooth Pairing Request

“BLE Keyboard” would like to pair with your iPod touch.

Figure 15. Android Settings for Paired Bluetooth Device



98% 18:47

Paired Bluetooth device

Rename

BLE Keyboard

Unpair

Profiles

Input device ☑

Connected to input device.

Related Documents

Application Notes		
AN210781	Getting Started with PSoC 6 MCU with Bluetooth Low Energy (BLE) Connectivity	Describes the PSoC 6 MCU with BLE Connectivity, and how to build a basic code example.
AN215656	PSoC 6 MCU Dual-Core CPU System Design	Presents the theory and design considerations related to this code example.
Software and Drivers		
CySmart – BLE Test and Debug Tool		CySmart is a BLE host emulation tool for Windows PCs. The tool provides an easy-to-use GUI to enable the user to test and debug their BLE Peripheral applications.
PSoC Creator Component Datasheets		
Bluetooth Low Energy (BLE_PDL) Component		The Bluetooth Low Energy (BLE_PDL) Component provides a comprehensive GUI-based configuration window to facilitate designing applications requiring BLE connectivity.
Device Documentation		
PSoC 6 MCU: PSoC 63 with BLE Datasheet Programmable System-on-Chip		PSoC 6 MCU: PSoC 63 with BLE Architecture Technical Reference Manual (TRM)
Development Kit (DVK) Documentation		
CY8CKIT-062-BLE PSoC 6 BLE Pioneer Kit		

Document History

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Document Number: 002-15121

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	5968177	NPAL	11/15/2017	New spec

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