Objective

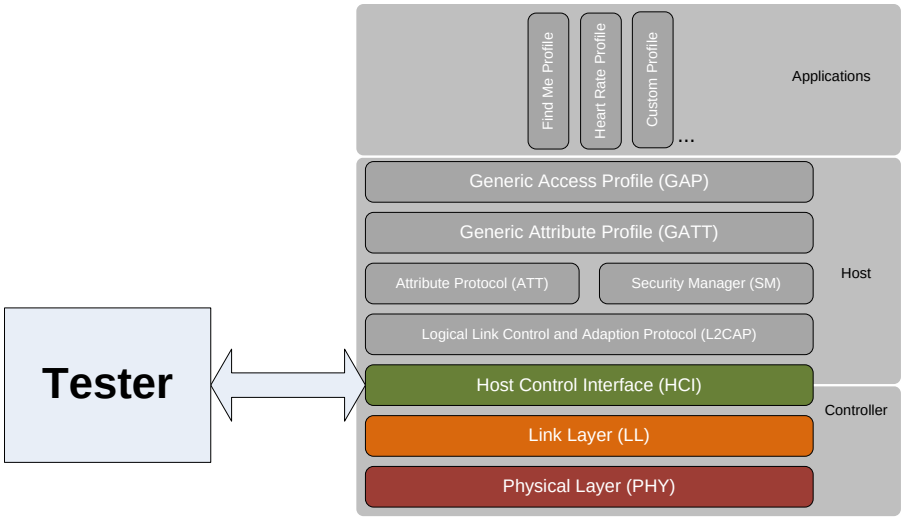
This example demonstrates Direct Test Mode (DTM) over the Host-Controller Interface (HCI) using PSoC 4 BLE.

Overview

This example implements the Direct Test Mode (DTM) as per BLE specification v4.1, Vol 6, Part F. The DTM allows testing the physical (PHY) layer of the radio by requesting the device to transmit or receive certain test packets. It is used for RF qualification tests and production line tests, without the need of going through the complete BLE protocol stack.

DTM is run over the standard Host-Controller Interface (HCI). HCI is the protocol layer that bridges the BLE Host with the Controller.

Figure 1. Direct Test Mode (DTM) over Host Controller Interface (HCI)



DTM setup has two parts:

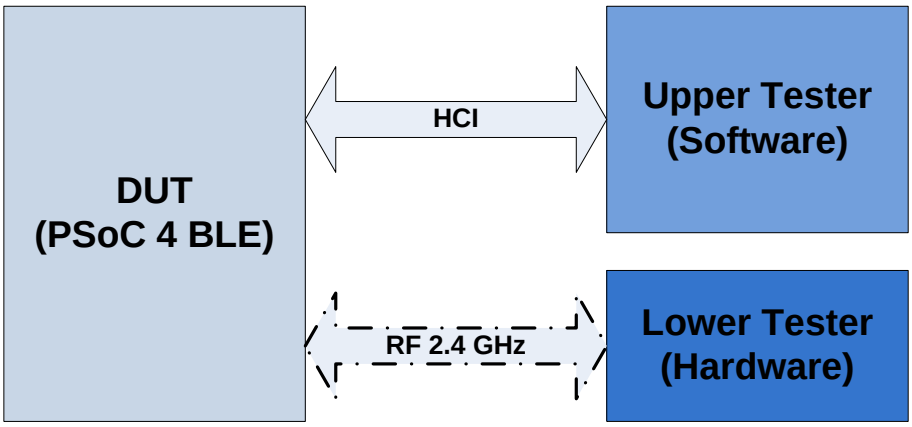
1) **Device under Test** (DUT): The device whose radio has to be tested, such as BLE Pioneer Kit with PSoC 4 BLE.
2) **Tester**: The system that performs the test on DUT.

The Tester in DTM can be divided into two parts, as shown in Figure 2:

1) **Upper Tester**: The part of the tester that communicates commands with DUT, over HCI interface.
2) **Lower Tester**: The part of the tester that communicates test packets with DUT over RF.

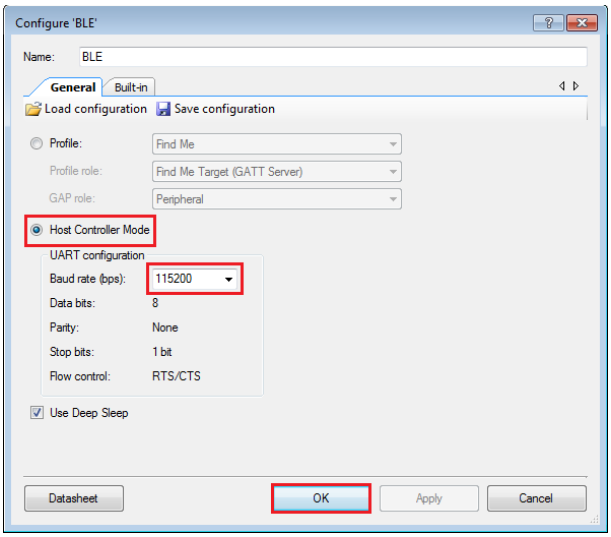
Most of the commercially available testers contain both Upper tester and Lower tester, along with Software tools to configure tests and read reports.

Figure 2. HCI DTM project



PSoC 4 BLE supports DTM using the HCI interface. The HCI is enabled from the **General** tab in BLE Component. Note that as soon as HCI mode is selected, the profiles related tabs becomes hidden, as the GAP and GATT layer are not used in HCI mode.

Figure 3. HCI mode in the BLE Component



The underlying physical communication for the HCI protocol is UART. Through UART, the commands and responses are communicated between the PSoC 4 BLE and Tester. When HCI mode is selected in the BLE component, a UART Component in PSoC 4 BLE is reserved for this use. The corresponding UART signals are exposed in the project's design wide resources (*HCI_DTM.cydwr*). These signals needs to be assigned to proper GPIOs on PSoC 4 BLE and connected to UART signals of the external tester.

When the BLE Component is configured for HCI mode, there is no further application code to be written to implement the DTM mode, except enabling global interrupts, starting BLE Component and processing BLE events. The proper response to commands from tester is handled by the BLE Stack as part of BLE Component.

Requirements

Tool: PSoC Creator 3.1 CP1

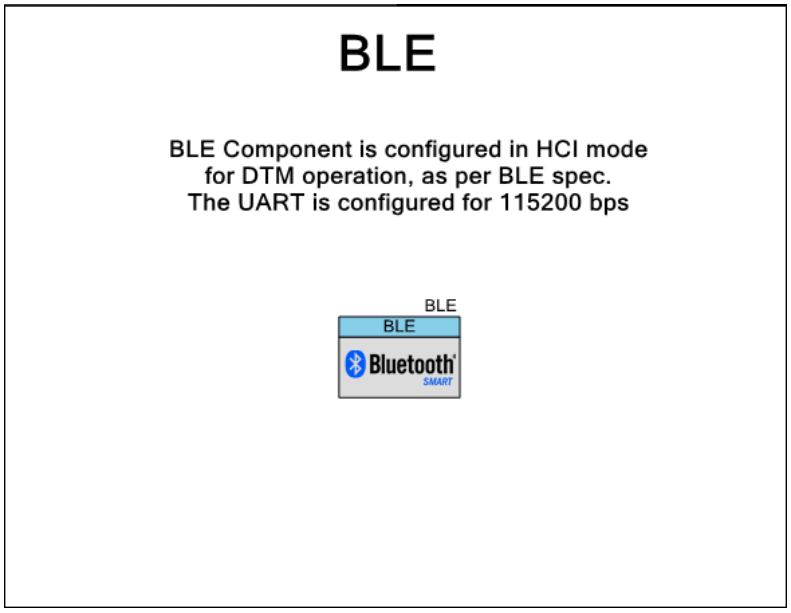
Programming Language: C (GCC 4.8.4 – included with PSoC Creator)

Associated Parts: All PSoC 4 BLE devices

Related Hardware: CY8CKIT-042-BLE, SMA Connector, Rohde&Schwarz CBT Tester or any other BLE tester

PSoC Creator Schematic

Figure 4. PSoC Creator Schematic (HCI DTM)



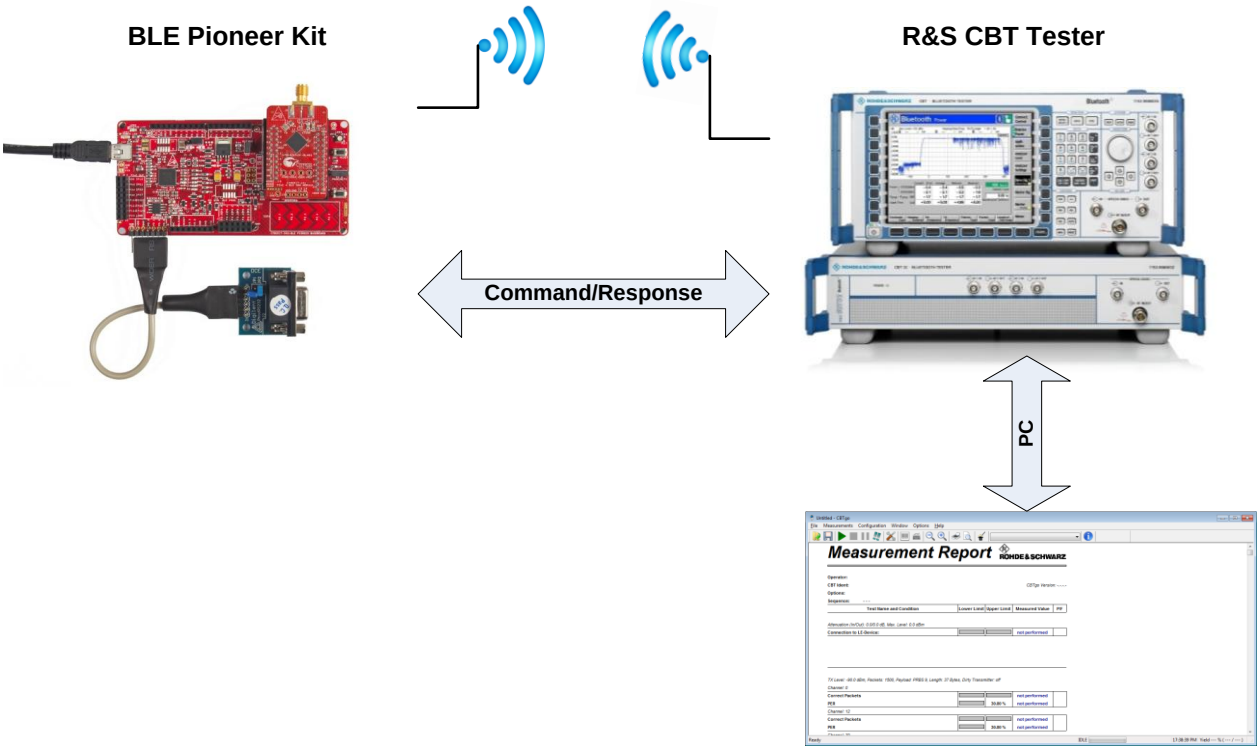
Hardware Setup

DTM requires that the RF signal between the DUT and tester should not have interference from any other source, so as to obtain correct RF performance measurement. For this, most of the setups use an SMA connector and a cable between the DUT and the Lower Tester.

Also, the Upper Tester communicates with the DUT over RS232. To use the BLE Pioneer Kit with these testers, a RS232 voltage translator is required. One such module is Digilent's Pmod RS232. The UART signals from the PSoC 4 BLE on BLE Pioneer Kit are connected to the pins on this module and the port is used to connect to the Upper Tester over RS232.

One such setup is demonstrated in Figure 5.

Figure 5. Hardware setup

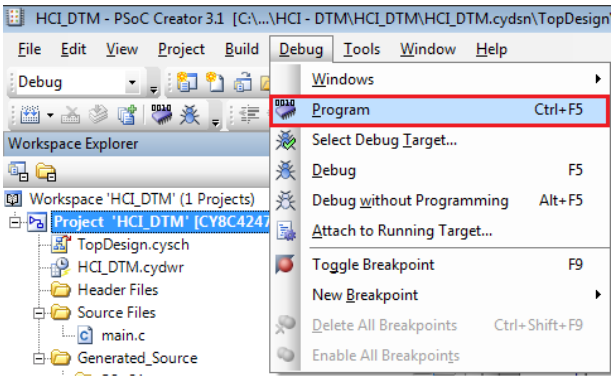


Testing

Setup the test by following these steps:

1) Open the PSoC Creator example project ***HCI_DTM***.
2) Connect the BLE Pioneer Kit with PSoC 4 BLE module to the PC using connector J13. Allow USB enumeration to complete.
3) Click on **Debug -> Program** to program the BLE Pioneer Kit with the ***HCI_DTM*** project.

Figure 6. Program HCI_DTM project



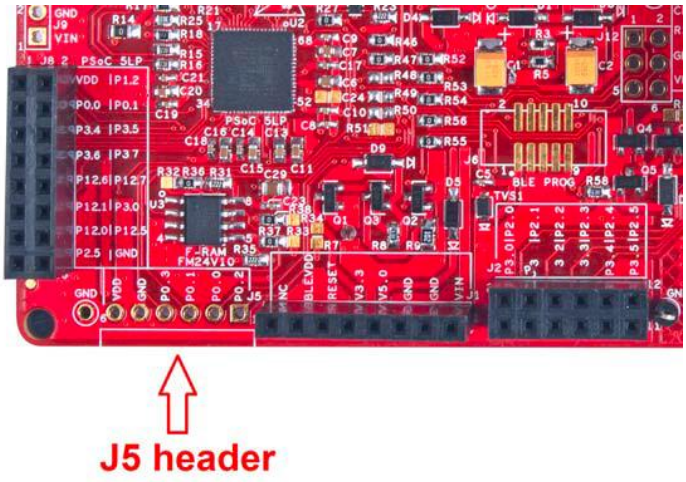
4) Disconnect the USB connection on BLE Pioneer Kit.

5) Connect the pins corresponding to the PSoC 4 BLE UART signals to the RS232 translator. The pins in the default project are as shown below, all accessible on the header J5 of the BLE Pioneer kit.

Table 1. UART Pins

UART Signal	PSoC 4 BLE GPIO
UART RX	P0_0
UART TX	P0_1
RTS	P0_2
CTS	P0_3

Figure 7. Header J5 on BLE Pioneer Kit



6) If the CBT tester does not use hardware flow control lines, leave the RTS pin floating and connect the CTS pin to ground.

7) Connect the CBT tester to the BLE Pioneer Kit using the RS232 cable.

8) If using the PSoC 4 BLE module with an SMA connector as the antenna, then connect this to the SMA connector of the CBT Tester by cable.

9) If using the PSoC 4 BLE module with a PCB antenna (the module included with the BLE Pioneer Kit), then connect a separate antenna to the SMA connector of the CBT tester.

10) Power the BLE Pioneer Kit using the USB cable (J13).

11) Using the USB connection, connect the CBT tester to the PC running the corresponding software tool.

12) Select the test sequence to run and start the test.

13) At the end of the test, the software tool will generate a report with the RF performance test results.

Related Documents

Table 2 lists all relevant application notes, code examples, knowledge base articles, device datasheets, and Component / user module datasheets.

Table 2. Related Documents

Document	Title	Comment
AN91267	Getting Started with PSoC 4 BLE	Provides an introduction to PSoC 4 BLE device that integrates a Bluetooth Low Energy radio system along with programmable analog and digital resources.
AN91445	Antenna Design Guide	Provides guidelines on how to design an antenna for BLE applications.