



THIS SPEC IS OBSOLETE

Spec No: 002-14934

Spec Title: AN214934 - BLUETOOTH LOW ENERGY  
CURRENT CONSUMPTION MEASUREMENTS

Replaced by: NONE

# Bluetooth Low Energy Current Consumption Measurements

Associated Part Family: CYW4330

This application note provides an introduction to the Bluetooth Low Energy (BLE) technology, and describes the setup and procedures to measure the basic current consumption in two of the most common BLE modes (advertising and scan mode). This application note is intended for hardware engineers and designers who are using the CYW4330 device in their design.

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## 1 Introduction

The CYW4330 implements the industry's most advanced radio coexistence algorithms and hardware mechanisms to allow an extremely collaborative WLAN and Bluetooth coexistence scheme, along with coexistence support for external radios (such as GPS and WiMAX). The result is an enhanced overall quality for simultaneous voice, video, and data transmission on a handheld system.

This application note provides an introduction to the Bluetooth Low Energy (BLE) technology, and describes the setup and procedures to measure the basic current consumption in two of the most common BLE modes (advertising and scan mode).

This application note is intended for hardware engineers and designers who are using the CYW4330 device in their design.

This document assumes that a user knows how to download firmware to the CYW4330 device. If the CYW4330 device has already been integrated onto a platform, the proper configuration files need to be loaded and the proper commands for BLE are generated by the host processor. If an evaluation board is being used, this can be accomplished by using Cypress's proprietary BlueTool™ software. Contact your local Cypress technical representative for BlueTool support.

### 1.1 Cypress Part Numbering Scheme

Cypress is converting the acquired IoT part numbers from Broadcom to the Cypress part numbering scheme. Due to this conversion, there is no change in form, fit, or function as a result of offering the device with Cypress part number marking. The table provides Cypress ordering part number that matches an existing IoT part number.

Table 1. Mapping Table for Part Number between Broadcom and Cypress

Broadcom Part Number	Cypress Part Number
BCM4330	CYW4330

## 1.2 Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined on first use.

For a comprehensive list of acronyms and other terms used in Cypress documents, go to:  
<http://www.cypress.com/glossary>

## 1.3 References

The references in this section may be used in conjunction with this document.

**Note:** Cypress provides customer access to technical documentation and software through its Cypress Developer Community and Downloads & Support site (see [Overview](#)).

For Cypress documents, replace the “xx” in the document number with the largest number available in the repository to ensure that you have the most current version of the document.

Document (or Item) Name	Broadcom Document Number	Cypress Document Number	Source
<b>Cypress Items</b>			
Cypress Bluetooth/WLAN Motherboard For Cypress Bluetooth and Wireless LAN Applications Testing, BCM9UMB Hardware User Manual	9UMB-HWUM100-R	—	<a href="#">Cypress Developer Community</a>

## 2 IoT Resources

Cypress provides a wealth of data at <http://www.cypress.com/internet-things-iot> to help you to select the right IoT device for your design, and quickly and effectively integrate the device into your design. Cypress provides customer access to a wide range of information, including technical documentation, schematic diagrams, product bill of materials, PCB layout information, and software updates. Customers can acquire technical documentation and software from the Cypress Support Community website (<http://community.cypress.com/>).

## 3 Overview

The Bluetooth Low Energy (BLE) technology is a global standard for very low-power wireless technology. The BLE devices can operate from coin cell batteries for applications that use low data rates. BLE devices can communicate wirelessly to dual mode Bluetooth-enabled devices. The connections are designed to be robust, short range, and low cost. The BLE-enabled devices are used in the area of fitness, advertising, medical, security, and home entertainment.

## 4 Comparing Bluetooth Low Energy to Bluetooth 2.x/3.x

The similarities between the Bluetooth and the BLE technology allow a Bluetooth transceiver to have dual-mode operation. Bluetooth and BLE technology can coexist in one device. For example, a BLE radio can use the following items from an existing Bluetooth radio:

- Radio architecture
- Host controller interface (HCI) logical and physical transports
- Logical link control and adaptation protocol (L2CAP)

The BLE technology differs from Bluetooth in the following areas:

- Discovery and connection procedures are handled differently when it comes to lowering total power consumption.
- BLE is limited to only one packet type.
- Connections are entered and always exited in sniff-like mode.
- Transmit and receive operations are governed by interframe spacing as opposed to being slot oriented.
- Profiles are thinner than standard Bluetooth and are structured around client/server architecture.
- BLE devices have lower duty cycles and only three advertising channels to lower connection time. The shorter enable and connection times result in lowering total power consumption.

The BLE devices can either be dual or single mode. The dual-mode devices are combined with a Bluetooth device for use in PCs, cell phones, and tablets. The single-mode devices are BLE only, and are designed to have very low power consumption. The single mode devices are typically small and can operate for a long period of time using a coin cell battery. The CYW4330 is a dual mode device with Bluetooth and BLE.

Table 2 lists specifications for the BLE and Bluetooth technology.

Table 2. BLE and Bluetooth Specifications

Specification	BLE Technology	Bluetooth Technology
RF section enable time	0.6 ms to 1.2 ms	22.5 ms
Device connection times	3 ms	100 ms
Peak transmit power	10 dBm	20 dBm
Frequency range	2402 to 2480 MHz	2402 to 2480 MHz
RF channel spacing	2 MHz	1 MHz
Channels used	40 channels	80 channels

## 5 Test Setup

This section describes the setup and procedures to measure the basic current consumption in BLE modes.

The current consumption is not measured in the typical method that is by using a multimeter, or adding a series resistor and an oscilloscope. The recommended method is to use a power analyzer. A power analyzer is power supply with the ability to make detailed current measurements. A power analyzer is used to measure peak current and average current consumption over a longer period of time. A power analyzer can measure both without having to use multiple pieces of equipment such as a scope and multimeter. BLE is mostly in sleep mode with a very short active period.

### 5.1 System Requirements

The system requirements are listed below.

- Host system requirements
- A personal computer running Microsoft® Windows® operating system is required to use BlueTool. Cypress recommends running Windows XP; however, other versions of Windows are supported.
- Hardware requirements
  - Agilent N6705A with N6761A precision power supply
  - CYW4330 McLaren daughterboard
  - BCM9UMB Bluetooth/WLAN motherhood
- Software Requirements
 

BlueTool is a proprietary Cypress software tool for exercising, testing, scripting, debugging, and programming devices that use Cypress Bluetooth chips. BlueTool runs on a standard PC running the Microsoft® Windows® operating system. BlueTool interfaces with the Cypress Bluetooth chips at the HCI protocol layer.

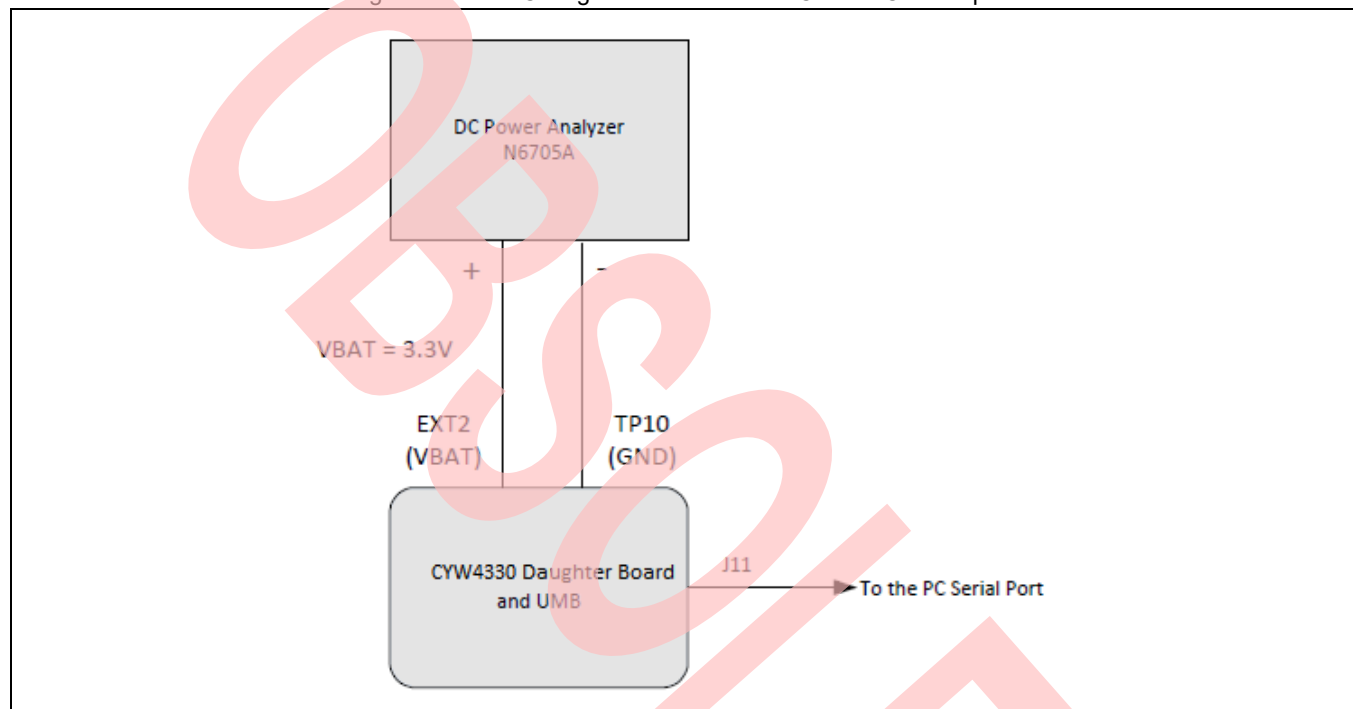
**Note:** For information on how to install BlueTool contact your Cypress representative.

## 5.2 Test Equipment Settings

Agilent N6705A with N6761A precision power module is used. Settings for the N6761A are:

- Range: 0.1A
- Current limit: 0.1A
- Sampling rate: 0.04 ms
- Mode: Data logger mode is used to capture current consumption

Figure 1. Board Configuration for the BLE Current Consumption

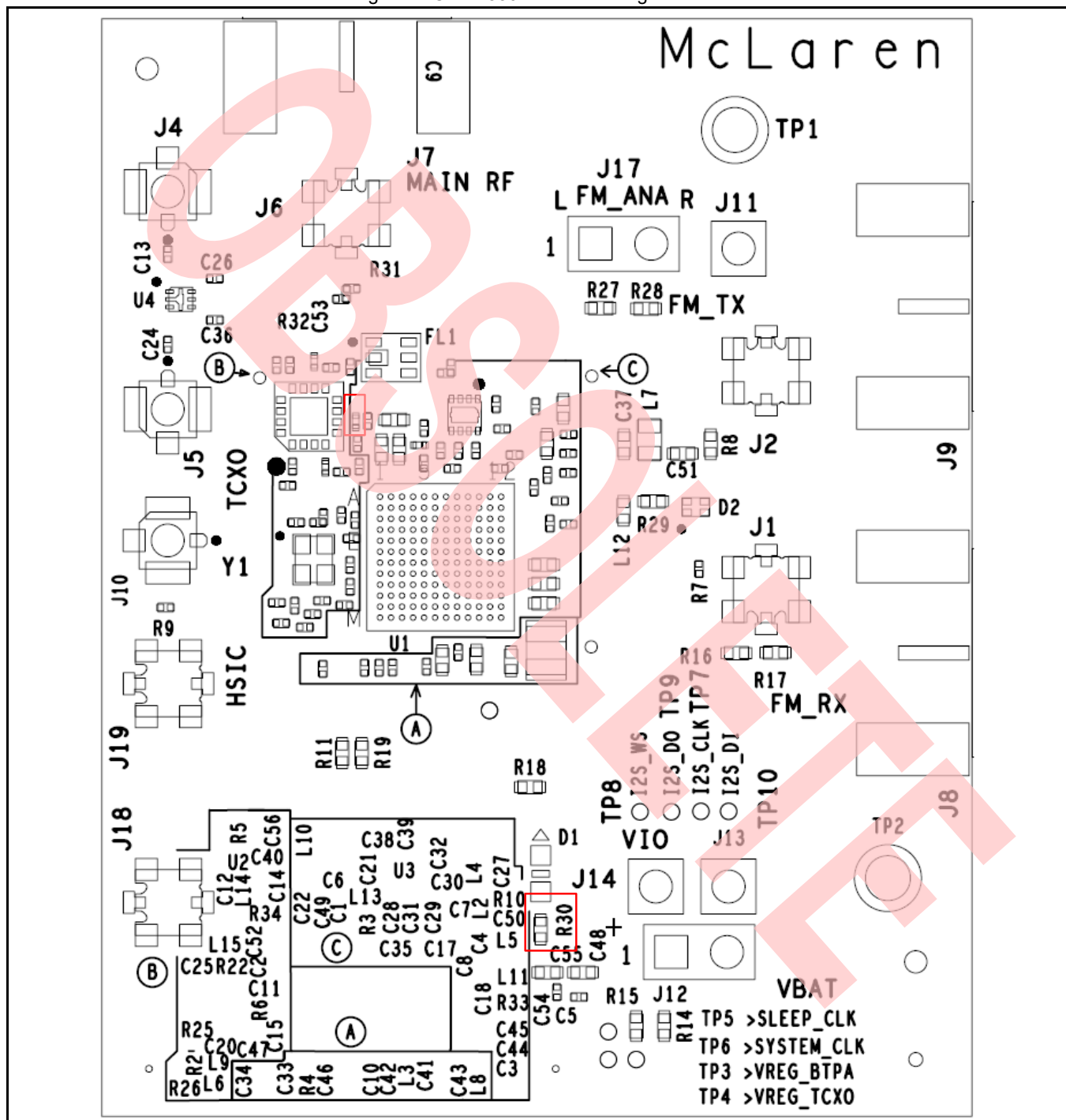


### 5.3 Daughterboard Settings

The McLaren daughterboard has to be configured prior to taking the measurements.

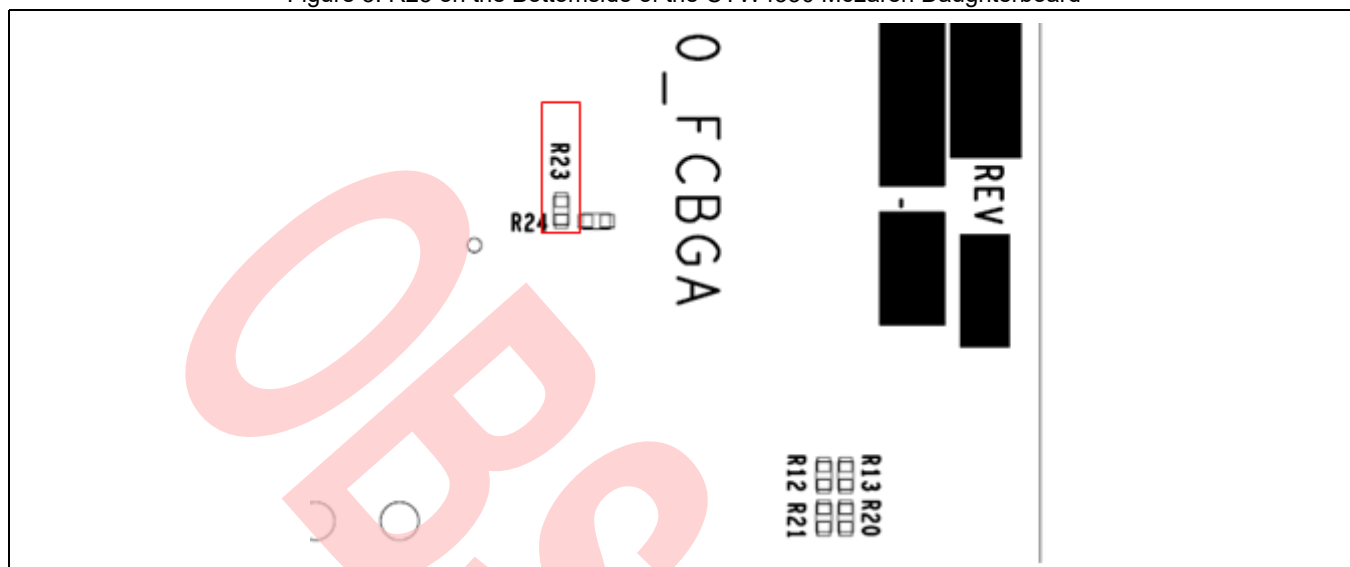
- Remove L10 and R30 on the topside of the board, refer to Figure 2.

Figure 2. CYW4330 McLaren Daughterboard



- Remove R23 on the bottomside of the board, refer to [Figure 3](#).

Figure 3. R23 on the Bottomside of the CYW4330 McLaren Daughterboard







To control BT\_WAKE, refer to Table 3 and Figure 6 for the schematic and switch location of SW4 on the bottom side of the board.

Note that the position 1 and 2 needs to be opposite of each other. BT\_WAKE has to be toggled to put the device into sleep mode and both switch positions need to be changed. See Figure 6 for schematic and switch logic. J28-1 can be used to measure the state of BT\_WAKE.

Figure 5. Bluetooth GPIO Controls

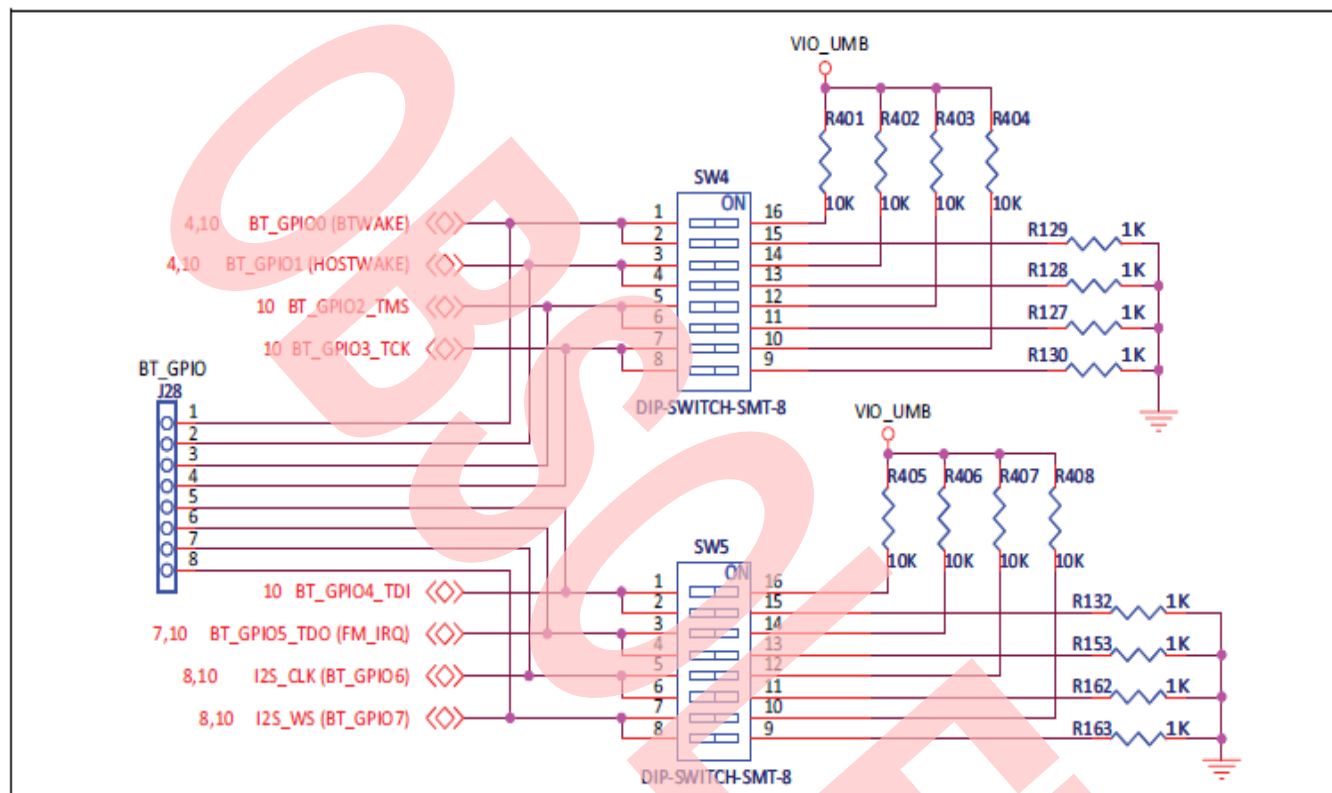
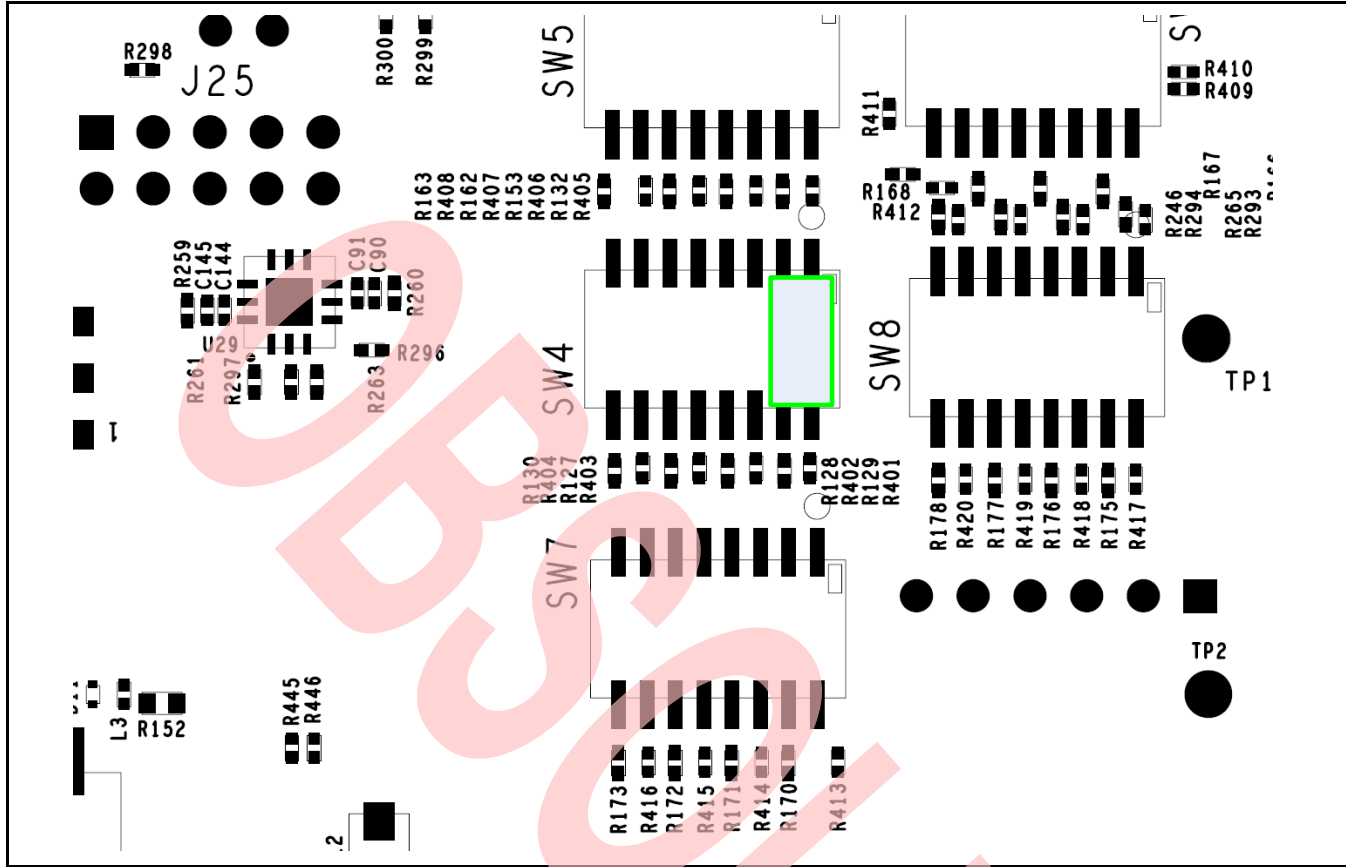


Table 3. Bluetooth GPIO Debug Settings for the SW4 DIP Switch

Signal/Configuration	IO Drive	
<b>BT_GPIO_0</b>	<b>Pole 1</b>	<b>Pole 2</b>
High	ON	OFF
Low	OFF	ON
Float (no connect)	OFF	OFF
<b>BT_GPIO_1</b>	<b>Pole 3</b>	<b>Pole 4</b>
High	ON	OFF
Low	OFF	ON
Float (no connect)	OFF	OFF
<b>BT_GPIO_2</b>	<b>Pole 5</b>	<b>Pole 6</b>
High	ON	OFF
Low	OFF	ON
Float (no connect)	OFF	OFF
<b>BT_GPIO_3</b>	<b>Pole 7</b>	<b>Pole 8</b>
High	ON	OFF
Low	OFF	ON
Float (no connect)	OFF	OFF

Figure 6. Switch Location of SW4

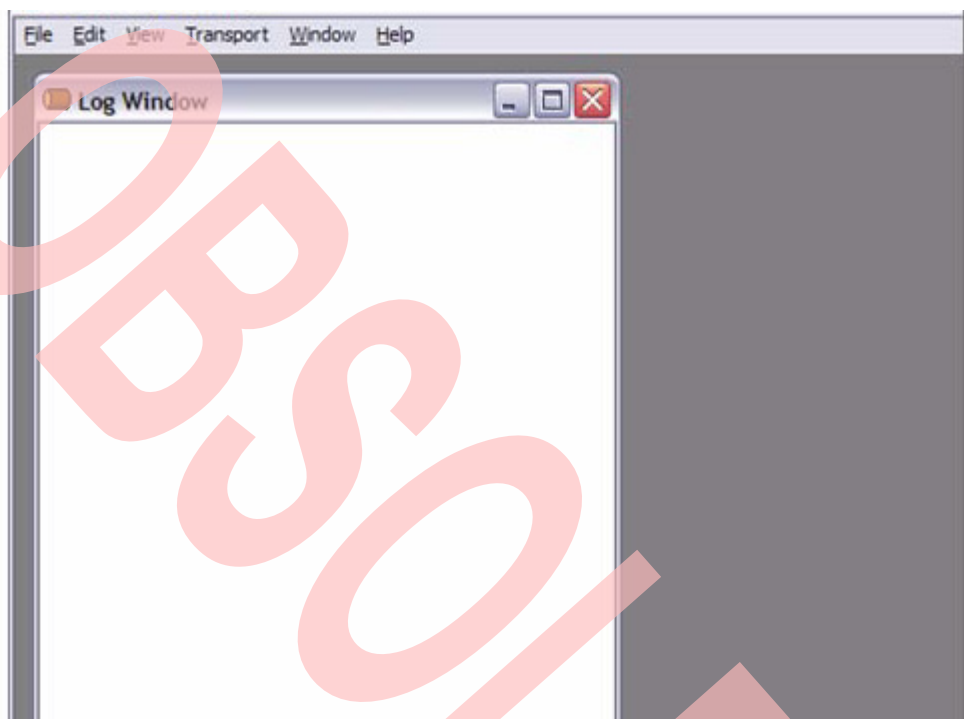


## 5.5 Loading the Configuration File

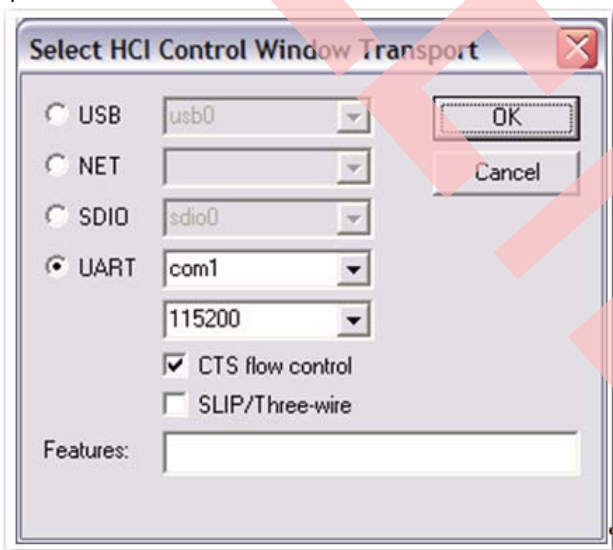
This document assumes that the user is familiar with BlueTool and hardware setup needed for collecting current consumption measurements. This section provides steps for loading the configuration file.

Follow these steps to load the configuration file after the CYW4330 McLaren daughterboard is powered up:

1. Launch the Cypress BlueTool software.
2. Enter **CNTL+0** to open the log window.

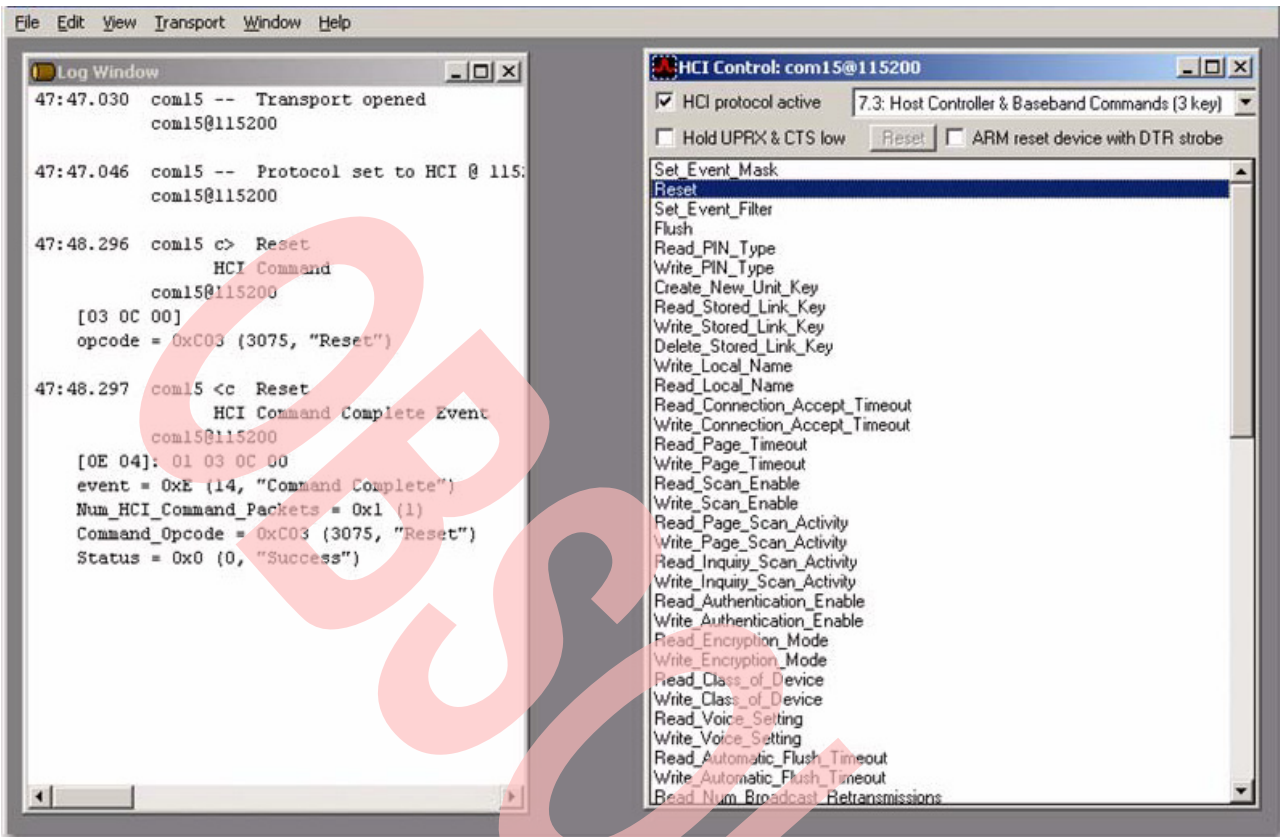


3. Enter **CNTL+1** to open the HCI Control Window.

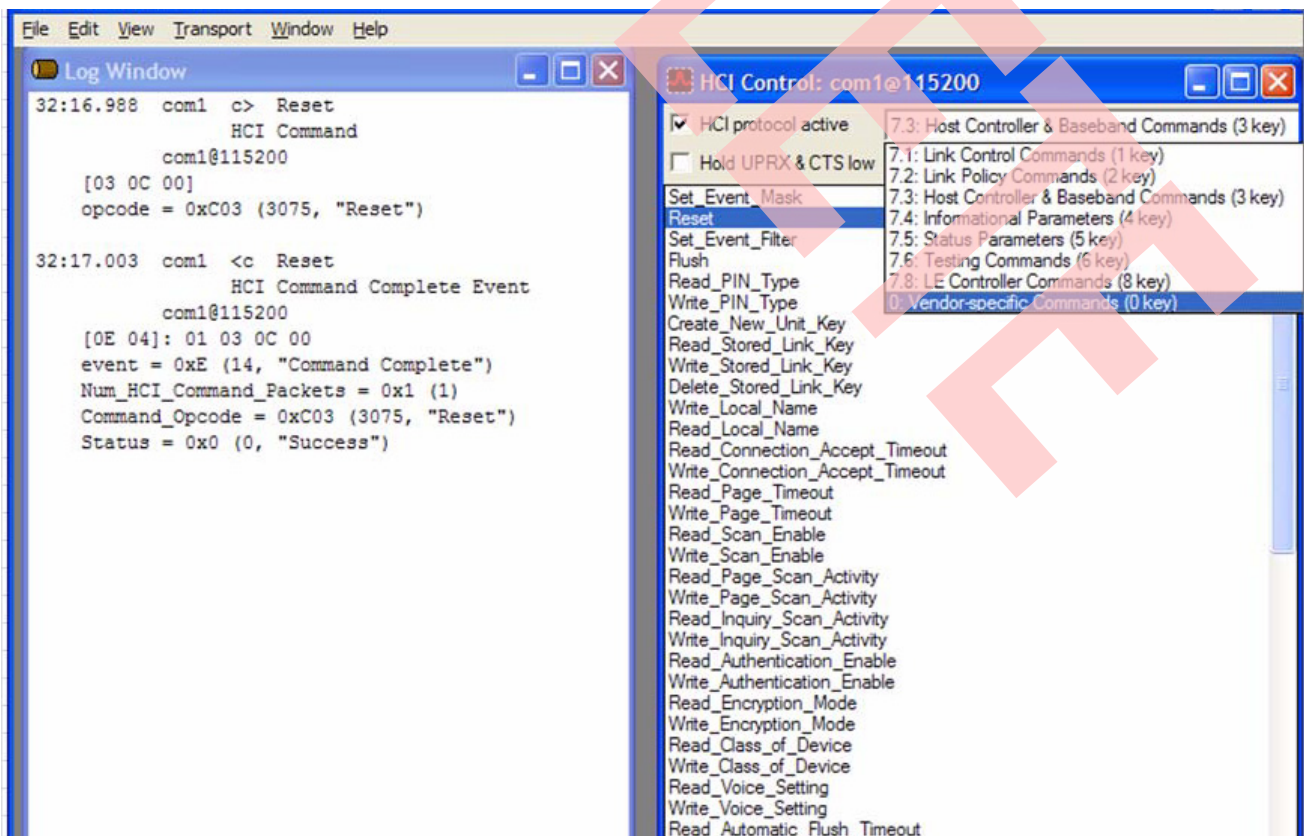


4. Select the port connected to the BCM9UMB, and click **OK**. Typically, it is COM1 or USB0.

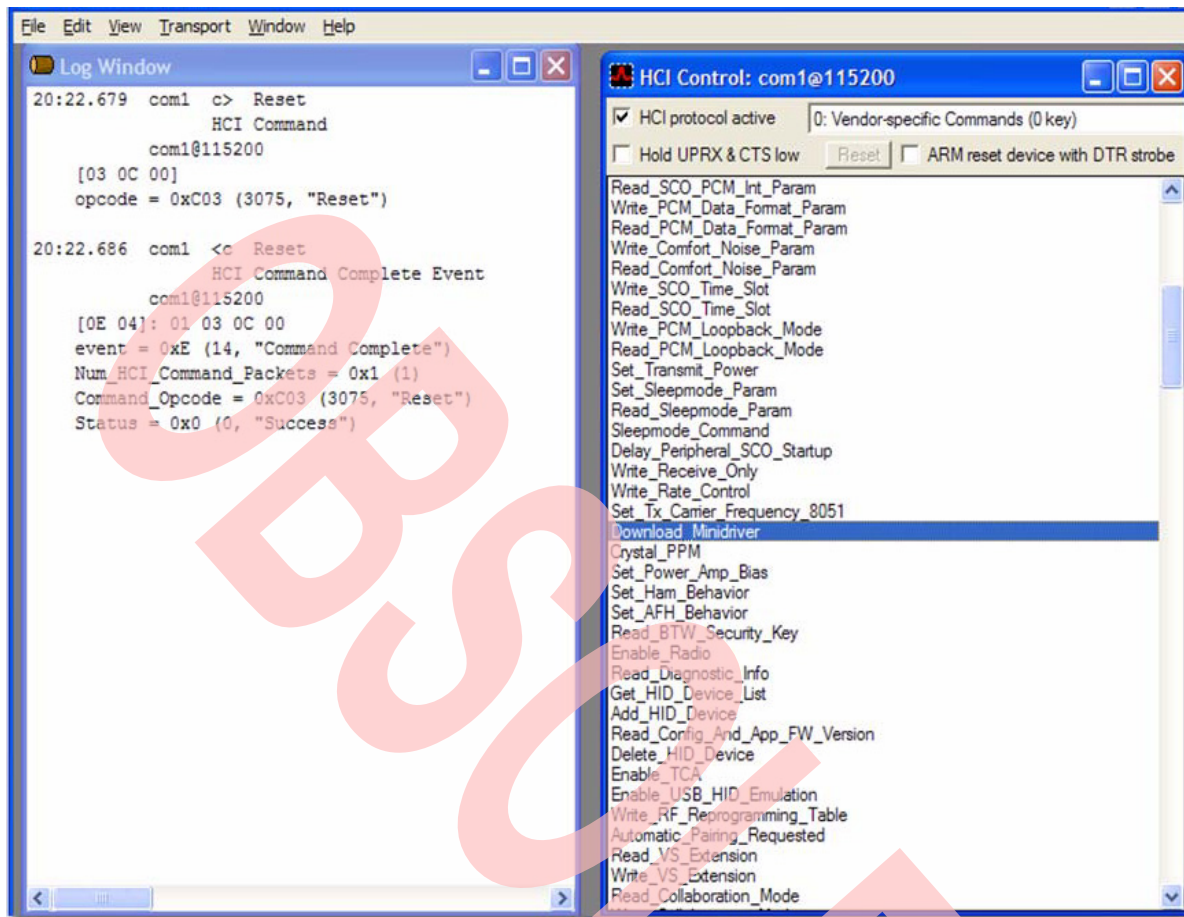
5. Click **Reset** and the log window should display 'success'.



6. Select the **0: Vendor-specific Commands (0 key)** from the list.

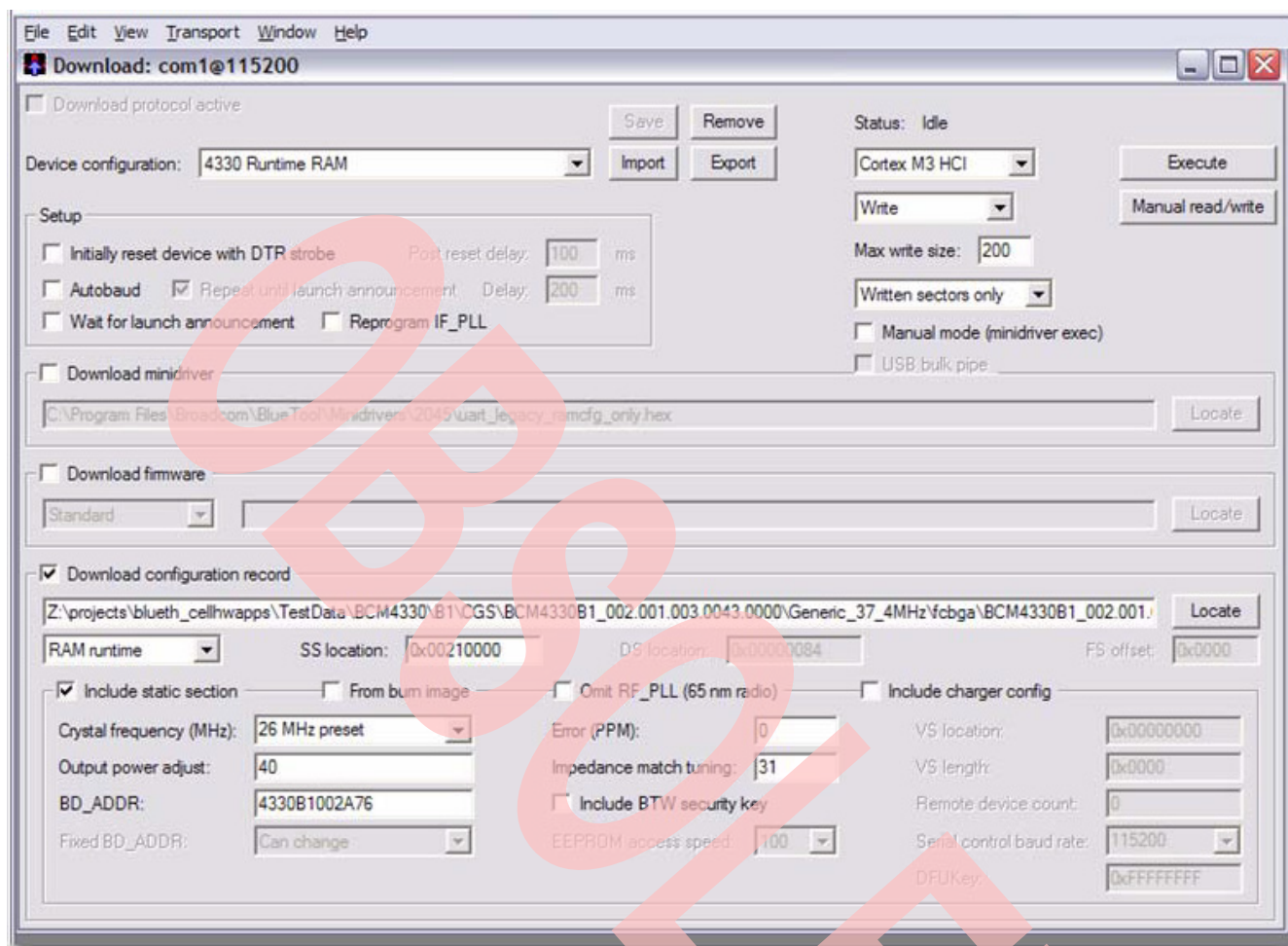


7. Select the **Download Minidriver** from the list and enter **CNTL+9**.





8. Locate the correct configuration file, and click **Execute**.



9. From the HCI control window, select the check box next to the HCI protocol active to enable the COM/USB port. Select **7.3 Host Controller & Baseband Commands (3 key)**, and click **RESET** to reset the device. In the log window the results should display 'success'.

## 6 Current Consumption Measurements

This application note provides current consumption measurements in two of the most common modes: advertising and scan mode.

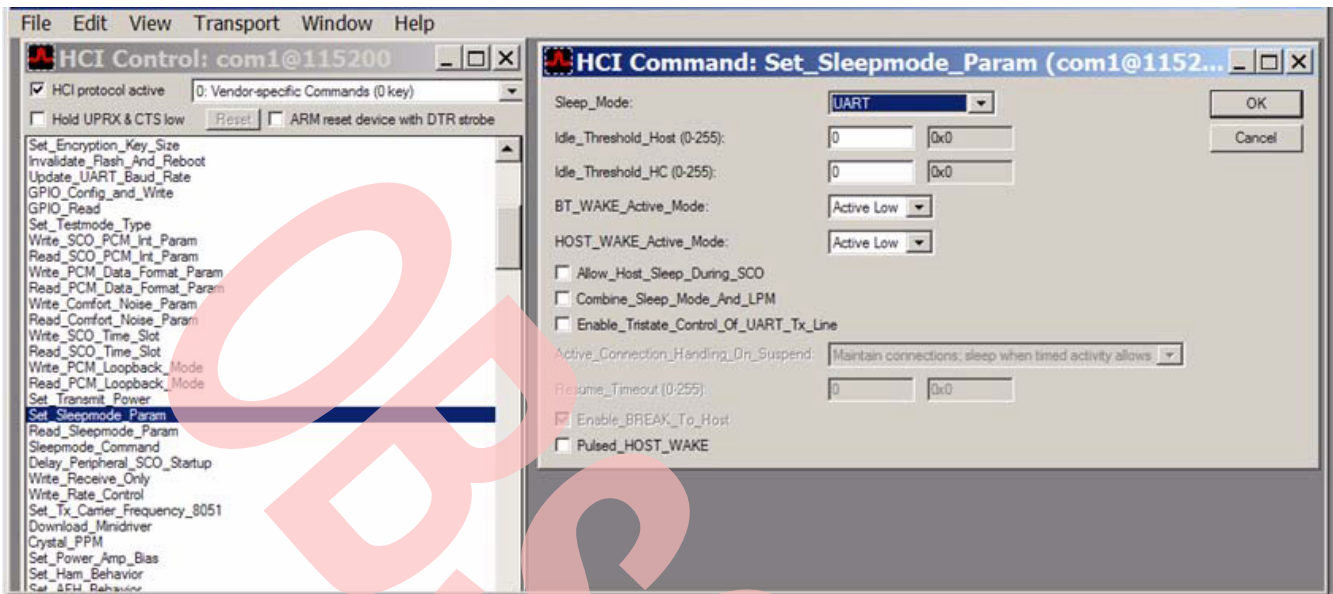
**Note:** Contact your local Cypress technical representative for BlueTool support and to download the configuration file (refer to [5.5. Loading the Configuration File](#)) needed for the following sections.

### 6.1 Advertising Mode

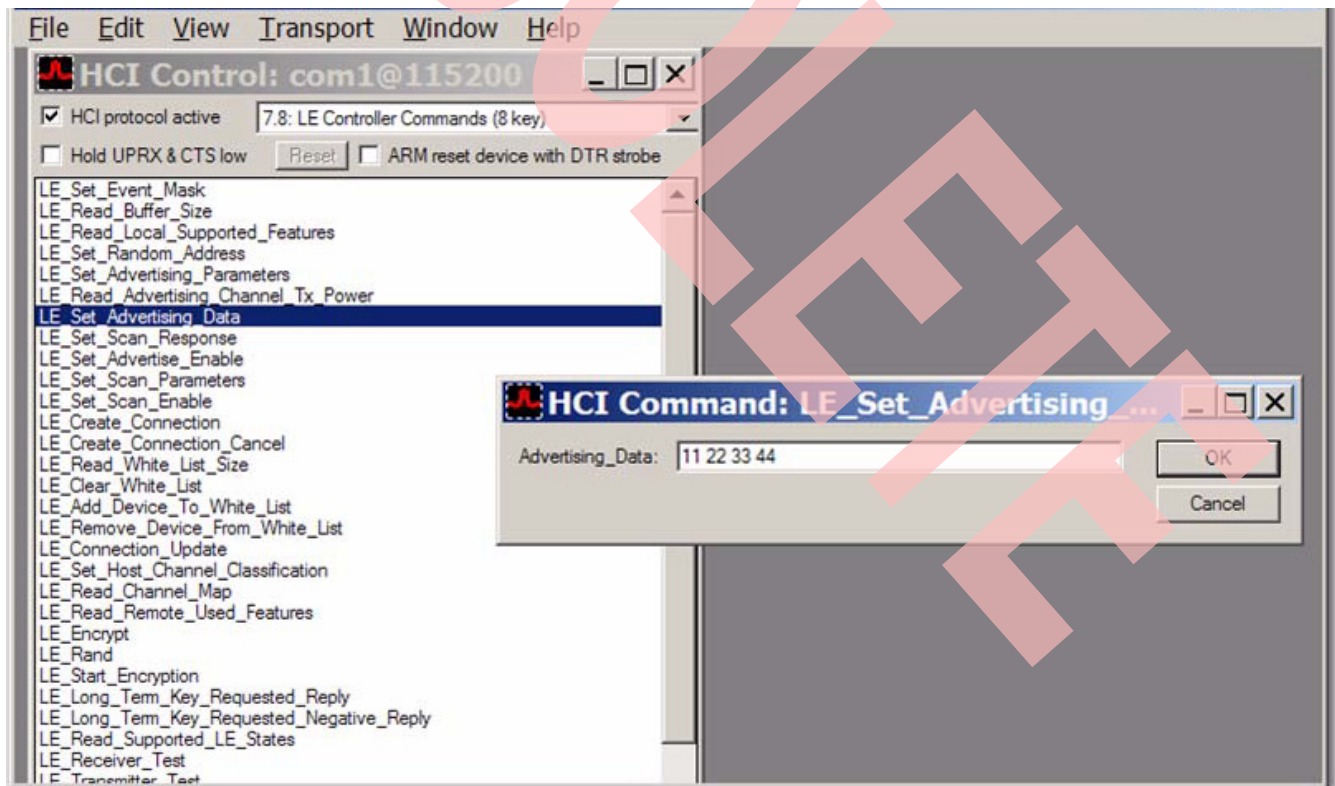
The BLE technology broadcasts connection packets in the advertising mode. For example, a temperature sensor broadcasts at certain intervals when temperature data is available. The devices that are scanning for data would then connect with the advertising device and download the temperature data. This is an example of a non-connected mode.

1. Launch the Cypress BlueTool software.
2. In the HCI Control window, select **0: Vendor-specific Commands (0 key)** from the list.
3. Select **Set\_Sleepmode\_Param** from the menu.

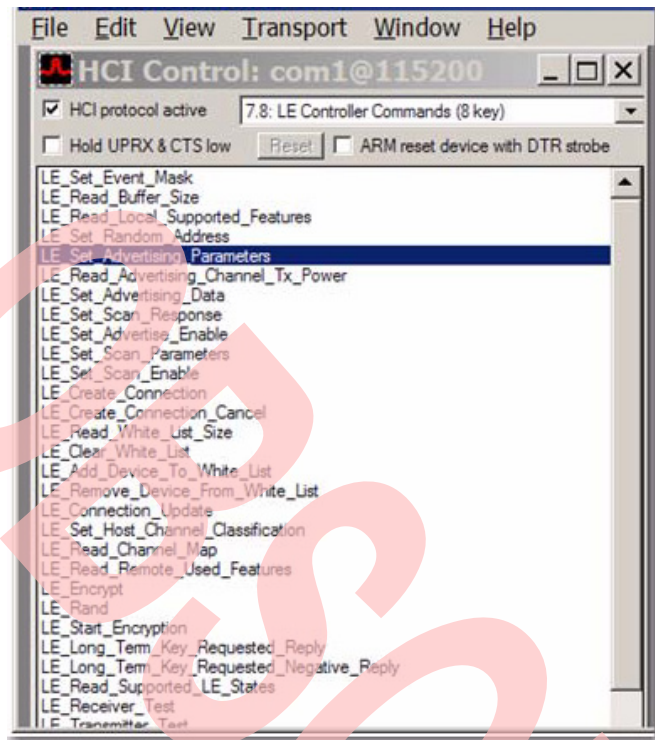
4. In the **Set\_Sleepmode\_Param** window, select **UART** from the Sleep\_Mode list. Ensure that the BT\_WAKE\_Active\_Mode is set to **Active Low**, and click **OK**.



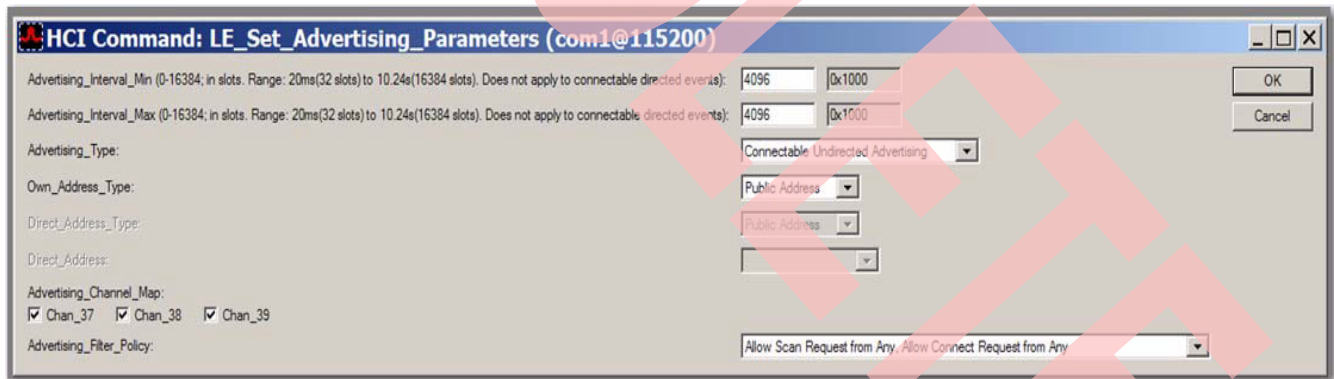
5. In the HCI Control window, select **7.8: LE Controller Commands (8 key)** from the list.
6. Select **LE\_Set\_Advertising\_Data** from the menu. Set the **Advertising\_Data** parameter with any 4 bytes.



7. Select **LE\_Set\_Advertising\_Parameters** from the menu.

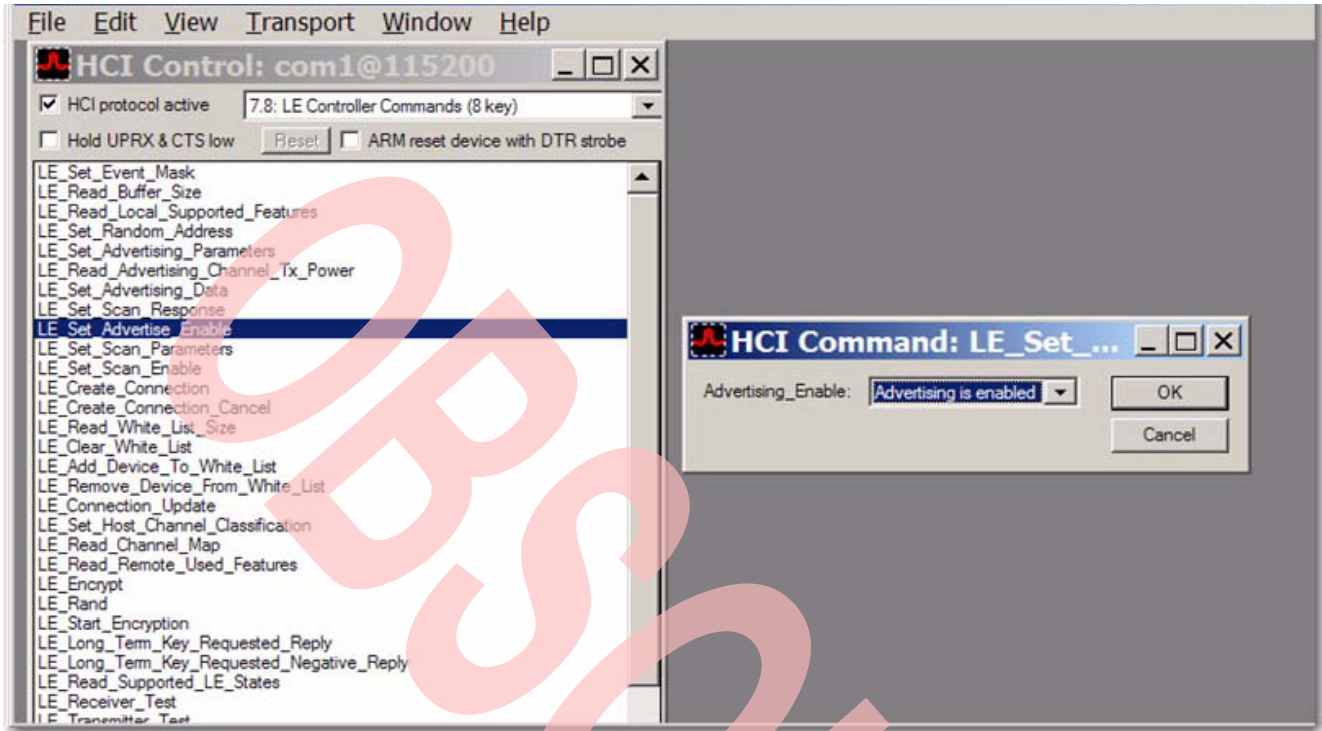


8. Set the **LE\_Set\_Advertising\_Parameters** by selecting both the Advertising\_Interval\_Min and Advertising\_Interval\_Max to 4096, click **OK**.





9. Select the **LE\_Set\_Advertise\_Enable** from the menu. In the Advertising\_Enable window, select **Advertising is enabled**, and click **OK**.

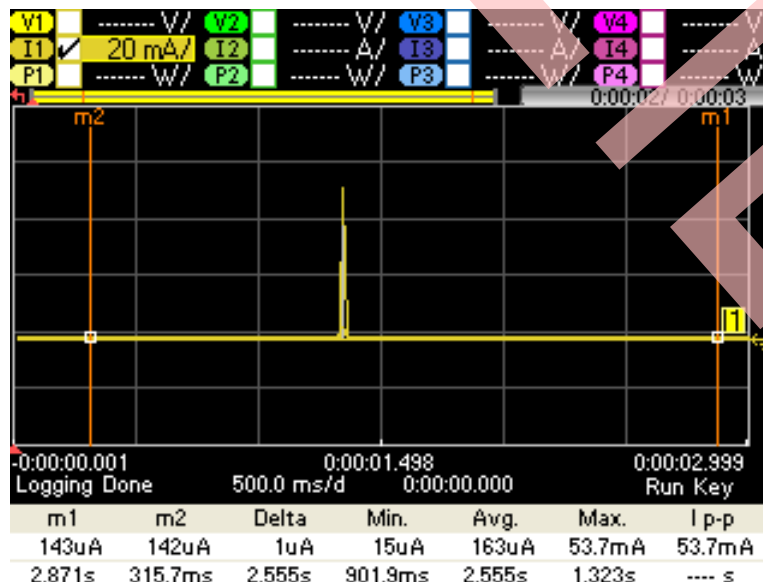


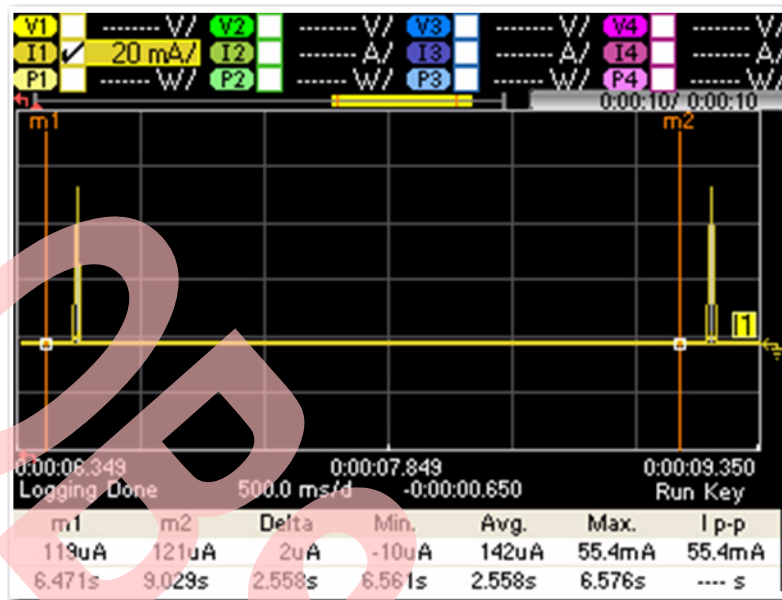
10. Put the device in Sleep mode before measuring the current or the current consumption will be approximately 4 mA.

To put the device in Sleep mode, toggle position 1 and 2 of the SW4 (refer to Figure 6 and Table 3 to set BT\_WAKE to high).

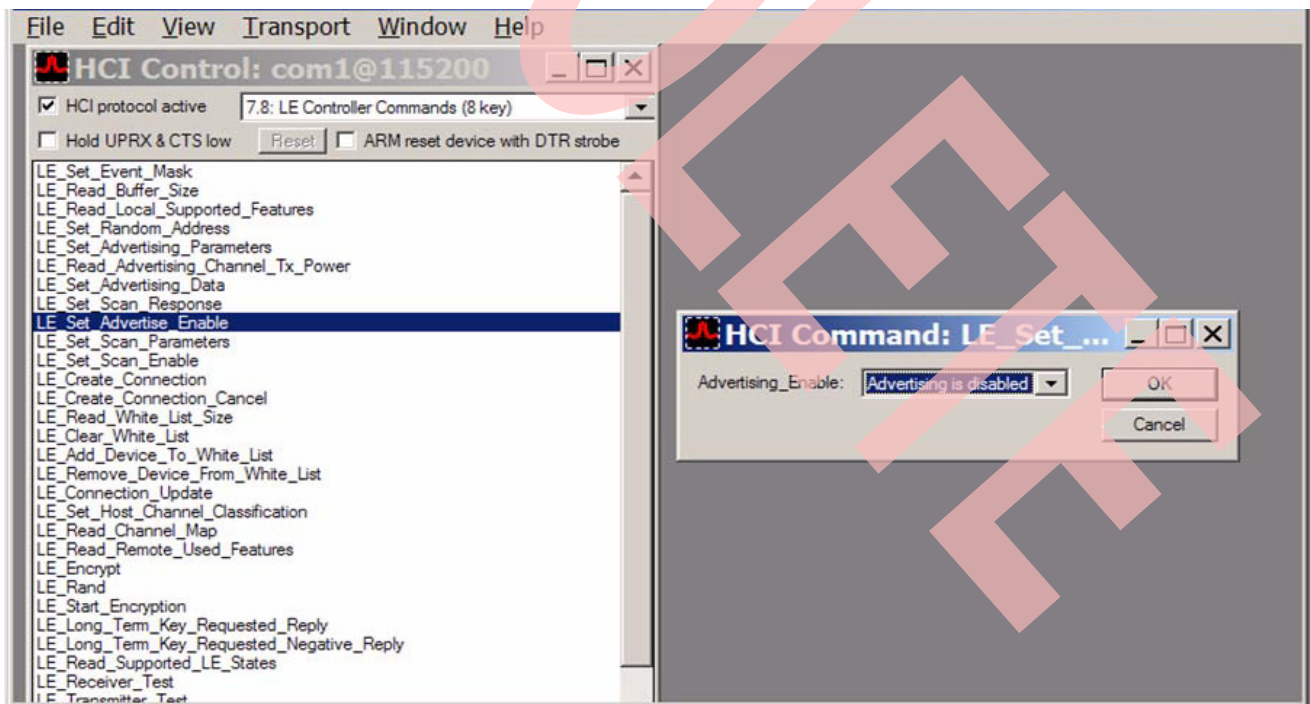
The results from the N6705A DC power analyzer are shown below. The average current consumption for the advertising mode is 162  $\mu$ A with 4 bytes of data. It is measured over 2.56 seconds (advertising interval).

The actual current consumption is approximately 142  $\mu$ A. The front-end module (U2) needs to be removed. There is 20  $\mu$ A of leakage, which is difficult to remove.





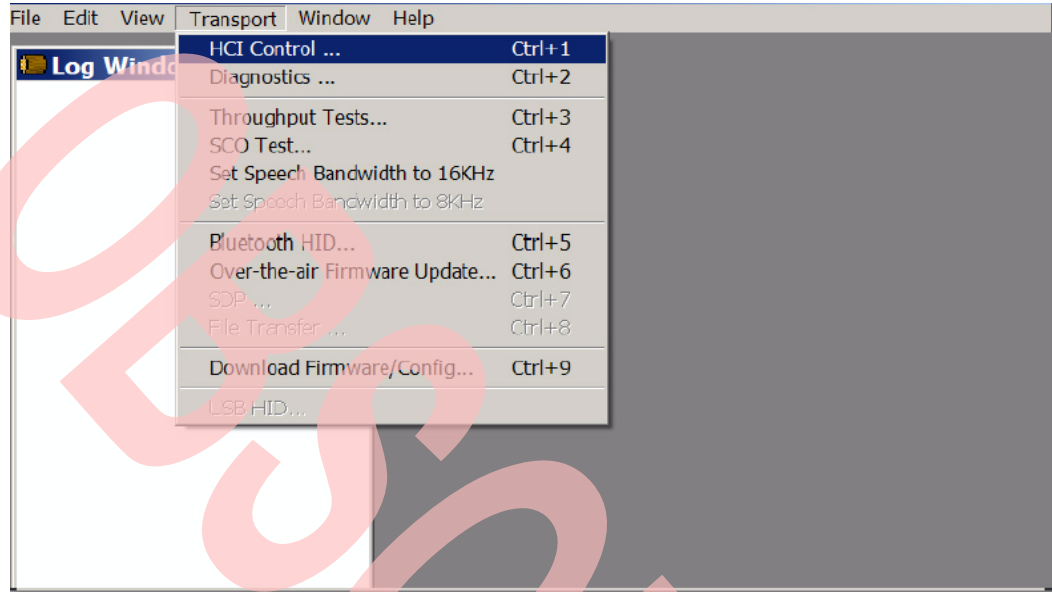
- Switch the BT\_WAKE to low by toggling position 1 and 2 of the SW4 (refer to Figure on page 8 and Table 3 for BT\_WAKE control).
- Select **LE\_Set\_Advertise\_Enable** from the menu. In the Advertising\_Enable window, select **Advertising is disabled**, and click **OK**.



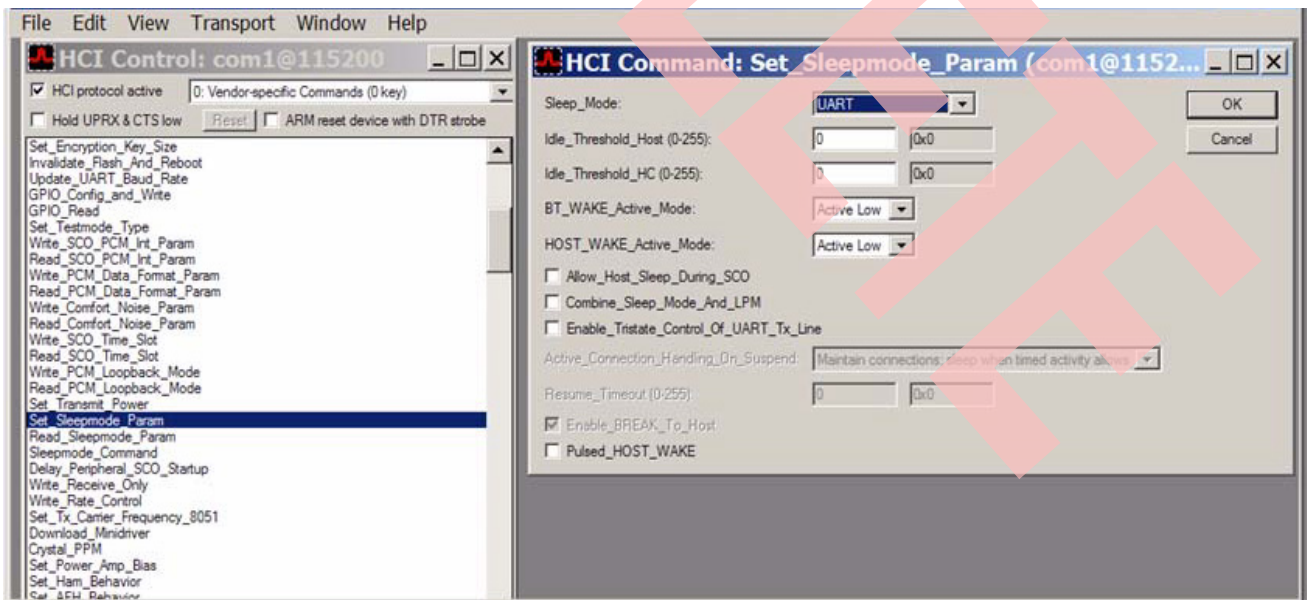
## 6.2 Scan Mode

The devices in scan mode look for advertisers to setup a connection. This is an example of a non-connected mode.

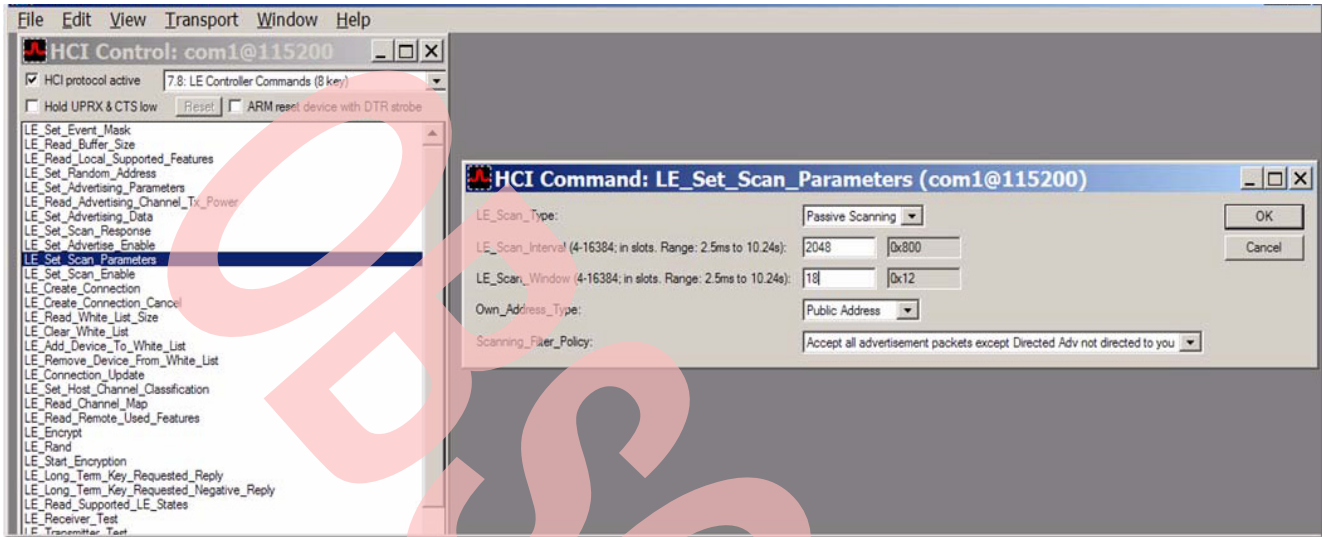
1. Launch the Cypress BlueTool software.
2. From the Transport menu, select **HCI Control** or enter **CNTL+1**.



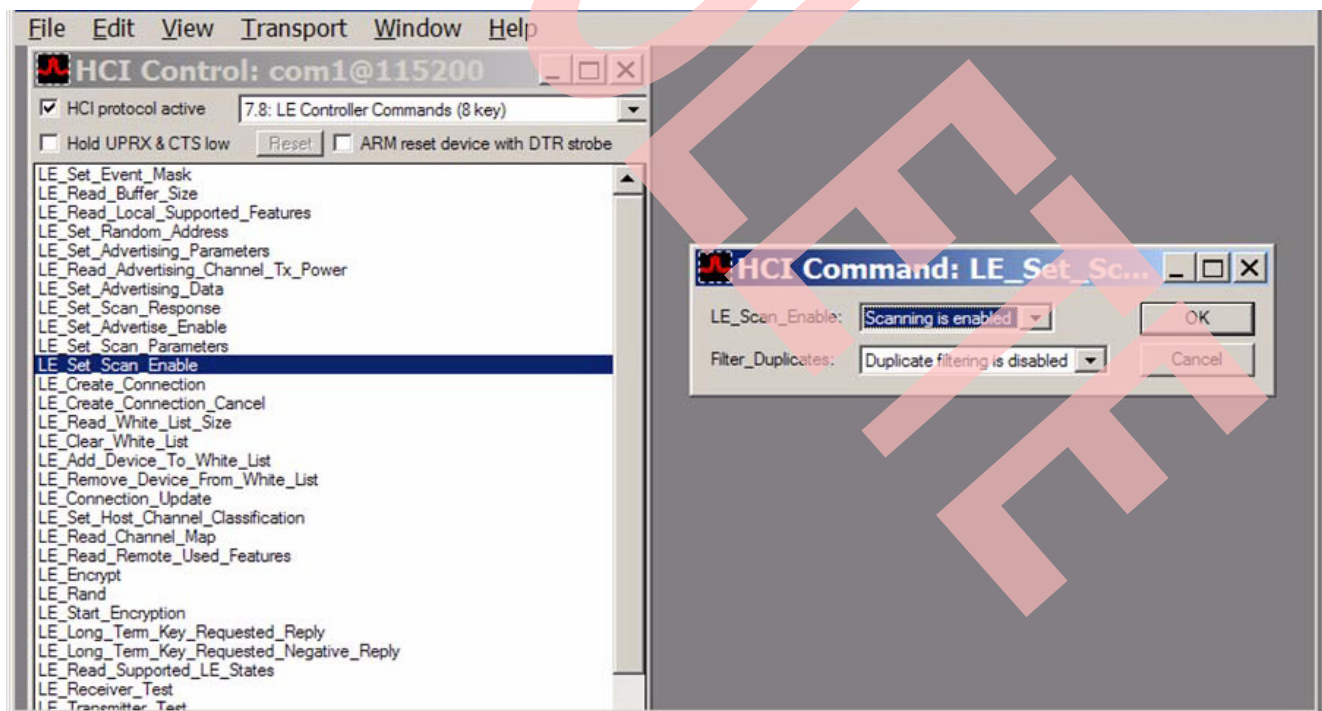
3. In the HCI Control window, select **0: Vendor-specific Commands (0 key)** from the list.
4. Select **Set\_Sleepmode\_Param** from the menu.
5. In the **Set\_Sleepmode\_Param** window, select **UART** from the Sleep\_Mode list. Ensure that the BT\_WAKE\_Active\_Mode is set to **Active Low**, and click **OK**.



6. In the HCI Control window, select **7.8: LE Controller Commands (8 key)** from the list.
7. Select **LE\_Set\_Scan\_Parameters** from the menu. Set the scan parameters as below, and click **OK**:  
 LE\_Scan\_type: **Passive Scanning**  
 LE\_Scan\_Interval: **2048**  
 LE\_Scan\_Window: **18**



8. Select **LE\_Set\_Scan\_Enable** from the menu. In the LE\_Scan\_Enable window, select **Scanning is enabled**, and click **OK**.



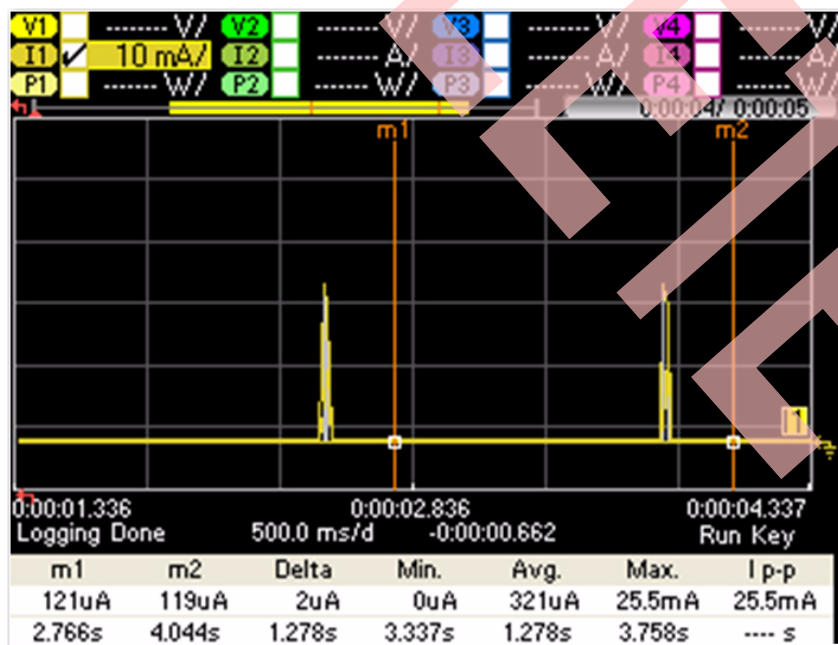
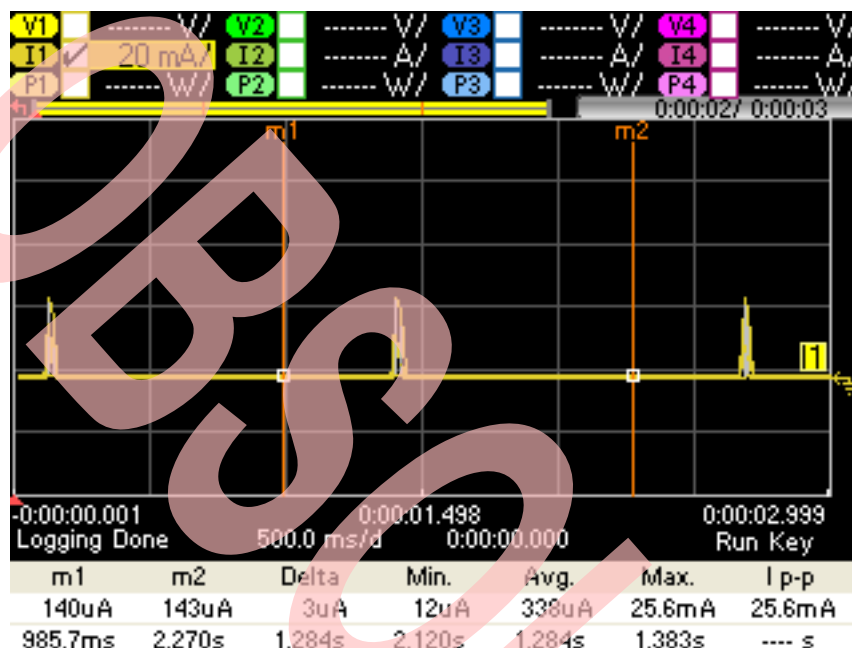


9. Put the device in Sleep mode before measuring the current consumption.

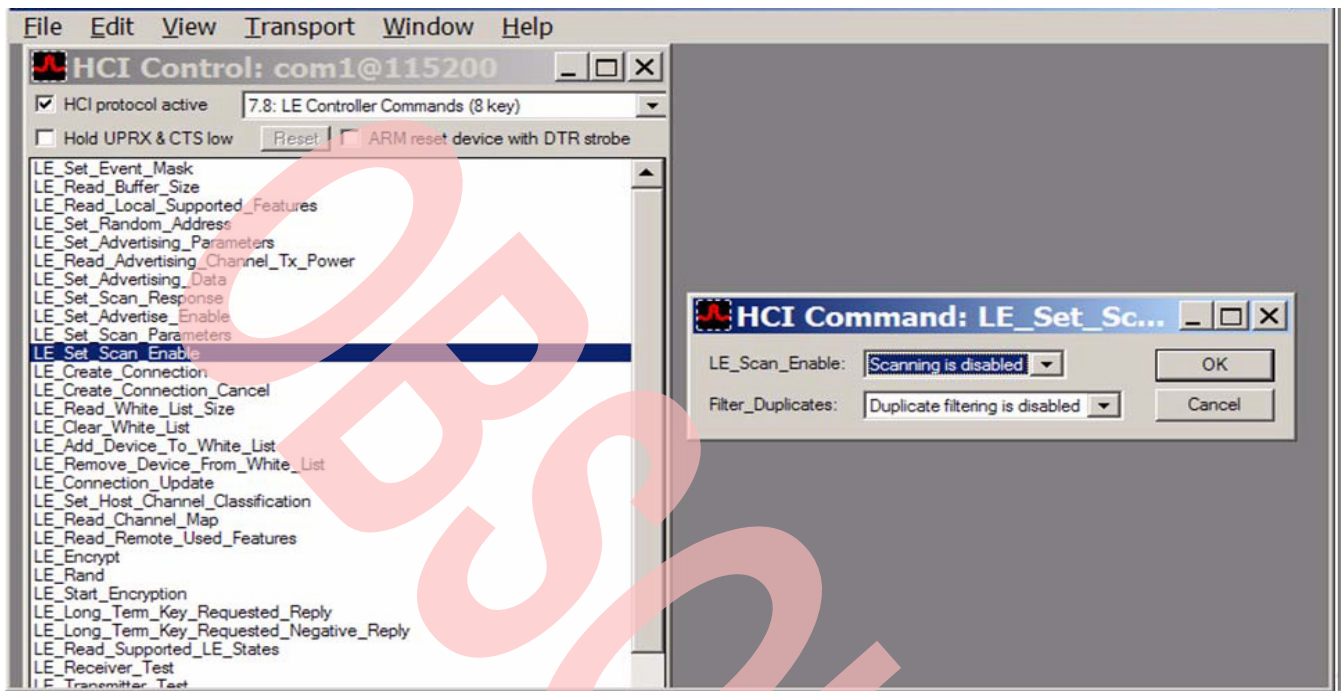
To put the device in Sleep mode, toggle position 1 and 2 of the SW4 (refer to [Figure 6](#) and [Table 3](#) to set BT\_WAKE to high).

The results from the N6705A DC power analyzer are shown below. The average current consumption for the scan mode is 341  $\mu$ A. It is measured over 1.28 seconds (scan interval).

Again, there is 20  $\mu$ A of current leakage in the front-end module (U2). The corrected current consumption should be approximately 321  $\mu$ A.



10. Switch the BT\_WAKE to low by toggling position 1 and 2 of the SW4 (refer to [Figure 6](#) and [Table 3](#) for BT\_WAKE control).
11. Select **LE\_Set\_Scan\_Enable** from the menu. In the LE\_Scan\_Enable window, select **Scanning is disabled**, and click **OK**.



## Document History Page

Document Title: AN214934 - Bluetooth Low Energy Current Consumption Measurements				
Document Number: 002-14934				
Rev.	ECN No.	Orig. of Change	Submission Date	Description of Change
**	—	—	05/12/2011	4330-AN400-R Initial release.
*A	5480516	UTSV	11/22/2016	Updated <a href="#">Introduction on page 1</a> : Added <a href="#">Cypress Part Numbering Scheme on page 1</a> . Updated to Cypress template.
*B	5881153	AESATMP8	09/12/2017	Updated Cypress Logo and Copyright.
*C	6580019	JPCH	05/23/2019	Obsolete document. Completing Sunset Review.

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