Running transmitter (Tx) and receiver (Rx) sensitivity tests on CYW920829M2EVK-02

About this document

Scope and purpose

This document demonstrates how to set up and run Tx and Rx sensitivity tests on CYW920829M2EVK-02.

Intended audience

This document is intended for application engineers and customers who want to evaluate the radio performance of AIROC™ CYW20829 using the CYW920829M2EVK-02 kit.

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1 Introduction

This document guides the user on how to download firmware to CYW920829M2EVK-02 in HCI mode and how to run basic Tx and Rx sensitivity tests to evaluate the radio performance of CYW20829.

1.1 Software requirements

Download the following:

Table 1 Software requirements

Software	Location
ModusToolbox™ software	www.infineon.com/modustoolbox
AIROC™ Bluetooth® Test and Debug Tool v1.2	softwaretools.infineon.com/tools/com.ifx.tb.tool.cybluetool
Firmware-loader	github.com/Infineon/Firmware-loader/releases

1.2 Hardware modifications

By default, CYW920829M2EVK-02 is configured to use the onboard PCB antenna. To use the U.FL connector for conducted test, set **C25** to position 'A'.

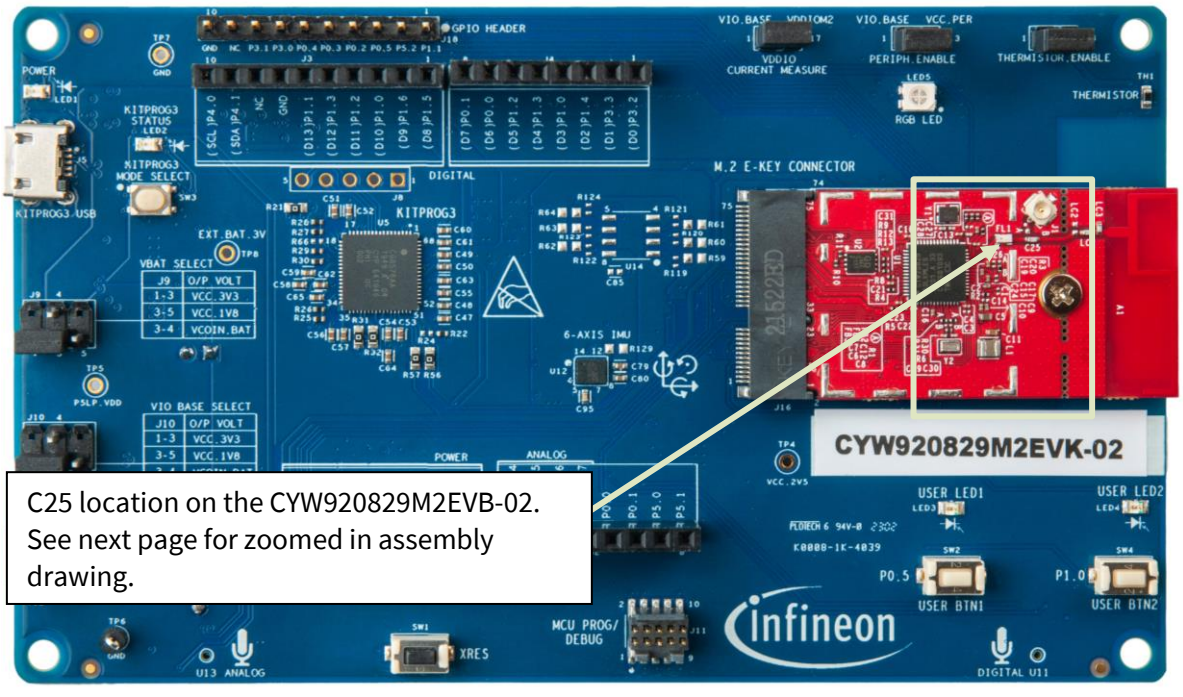

Figure 1 CYW920829M2EVK-02

Introduction

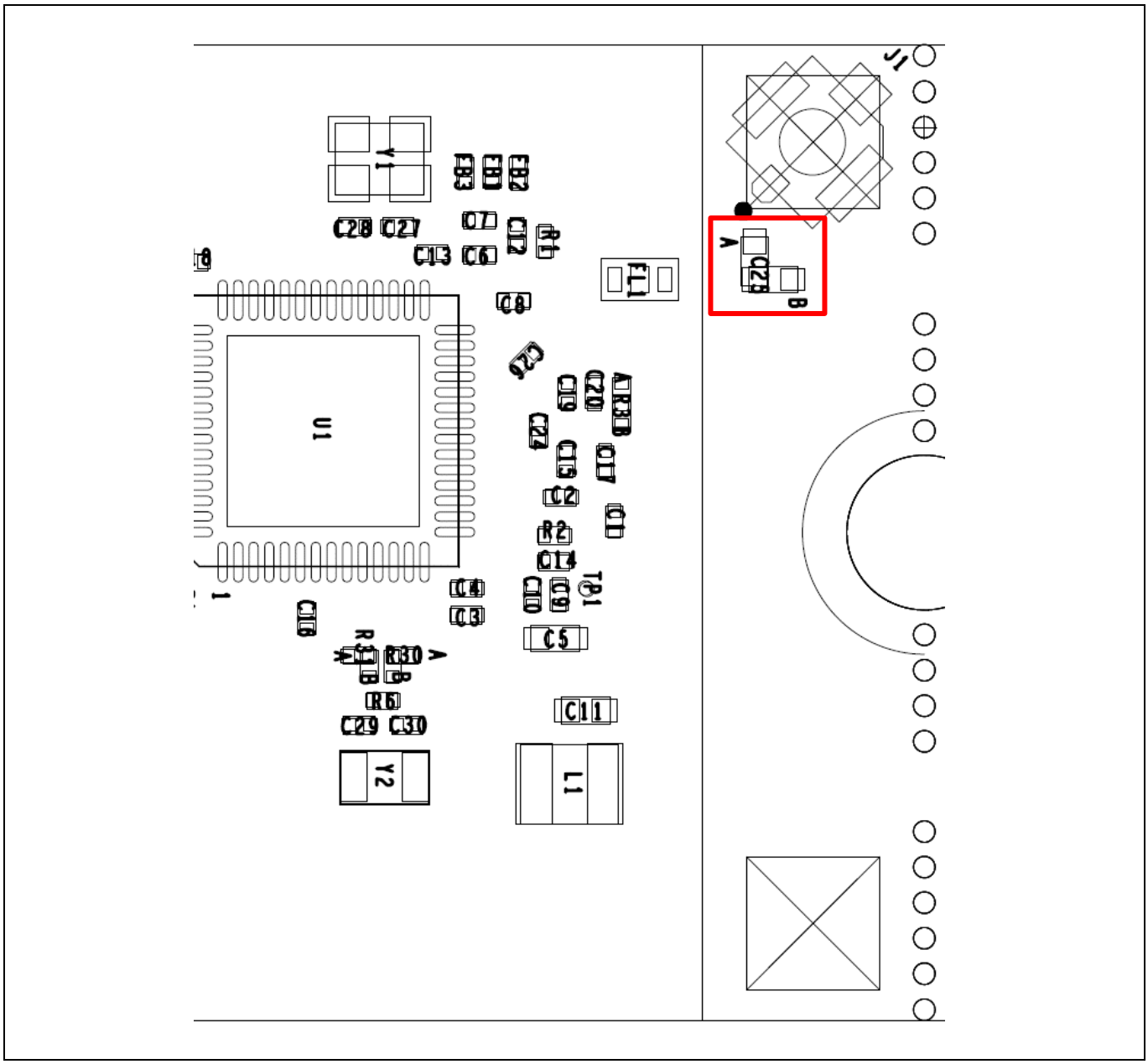

Figure 2 CYW920829M2EVK-02 top view, C25 assembly drawing

On the bottom side of the baseboard, move the zero-ohm resistor from R284 to the R285 position.

Introduction

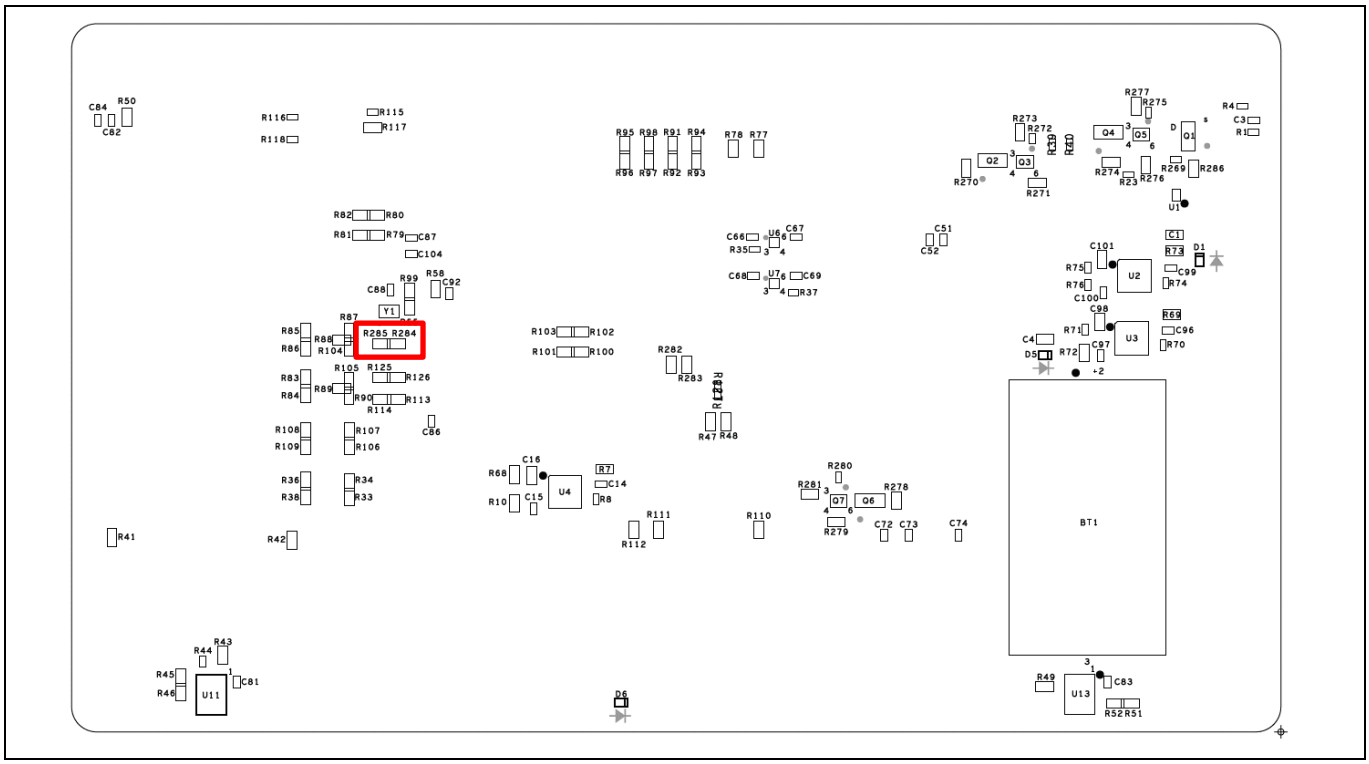

Figure 3 CYW920829M2EVK-02 bottom assembly drawing

2 Download the HCI loading tool onto CYW920829M2EVK-02

1. Connect CYW920829M2EVK-02 to the PC.
2. Install ModusToolbox™. By default, ModusToolbox™ will be installed to *C:\Users\<windows_user>\ModusToolbox.*
3. Open the command prompt, and change directory to *C:\Users\<windows_user>\ModusToolbox\tools_3.0\openocd\bin* to access *openocd.exe*.
4. Enter the following command in the terminal and then press **Enter**. The HCI loading app will be downloaded onto the CYW920829M2EVK-02 board.

```
openocd -s ../scripts -c "set ENABLE_ACQUIRE 0" -f interface/kitprog3.cfg
-f target/mxs40/cyw20829_common.cfg -c "init; reset init; reg pc [mrw
0xC004]; reg sp [mrw 0xC000]; resume; shutdown"
```

Note: Ensure the openocd command is in a single line when copying it from this document.

Note: If multiple CYW920829M2EVK-02 kits are plugged into the same PC, you must specify the CMSIS-DAP serial number for each kit in the command:

```
openocd.exe -s ../scripts -c "set ENABLE_ACQUIRE o" -f
interface/kitprog3.cfg -f target/mxs40/cyw20829_common.cfg -c
"cmsis_dap_serial 0511146602070400" -c "init;reset init;reg pc
[mrw 0xc004]; reg sp [mrw 0xc000]; resume; shutdown"
```

5. Do the following to obtain the CMSIS-DAP serial number:
   a) On the terminal, change directory to *fw-loader\bin*.
   b) Enter the following command in the terminal to obtain the CMSIS-DAP serial number:

```
fw-loader.exe --device-list
```

   The CMSIS-DAP serial number will be listed as follows. The following terminal output shows that two CYW920829M2EVK-02 kits are connected:

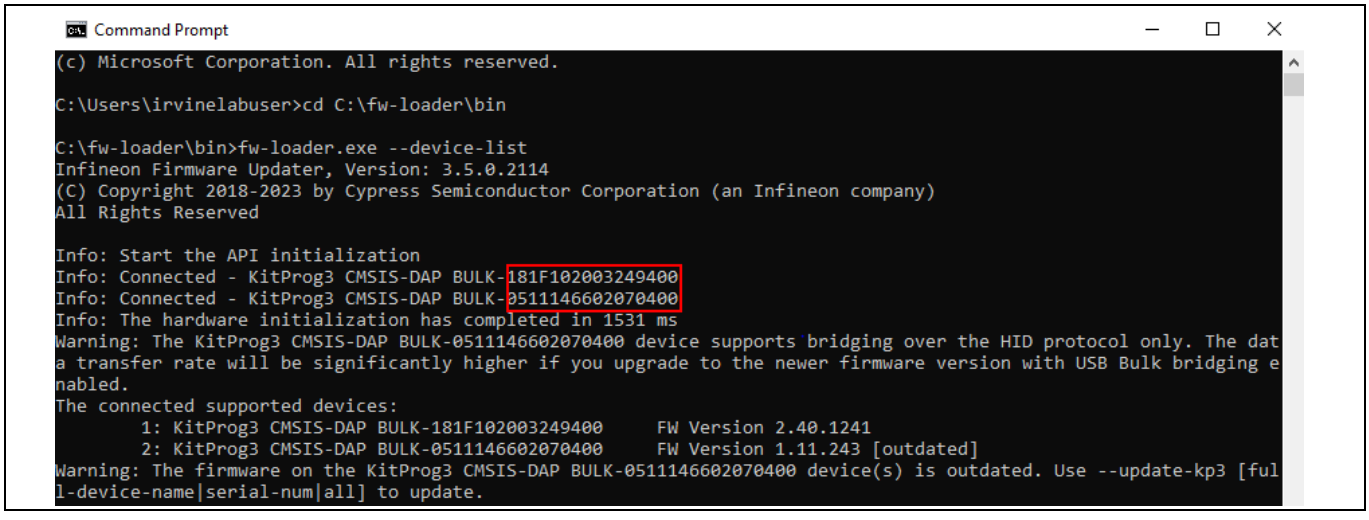

Figure 4 KitProg3 devices with CMSIS-DAP serial numbers

3 Download Bluetooth® firmware onto CYW920829M2EVK-02

1. Download and install AIROC™ Bluetooth® Test and Debug Tool v1.2 and open it.
2. Do the following to determine the COM port of the CYW920829M2EVK-02 board:
   a) Open Device Manager.
   b) Under **Ports (COM & LPT)**, look for "KitProg3 USB-UART (COMxx)". Note the device name—here, it is shown as "COM62".

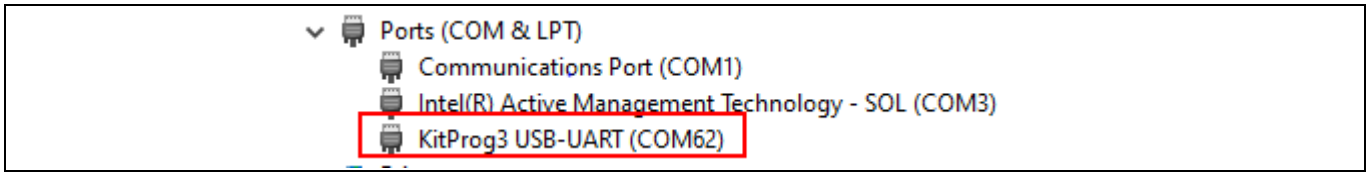

Figure 5 Identifying the COM port number from Device Manager

3. At the top left corner, click **Select Device**.
4. On the Select **Device** window, enter the following details and click **Open**. See Figure 6.
   - **Transport:** Select UART.
   - **Port name:** Select the COM port of CYW920829M2EVK-02.
   - **Baud rate (bps):** Select 115200.
   - **Flow control:** Select RTS/CTS.

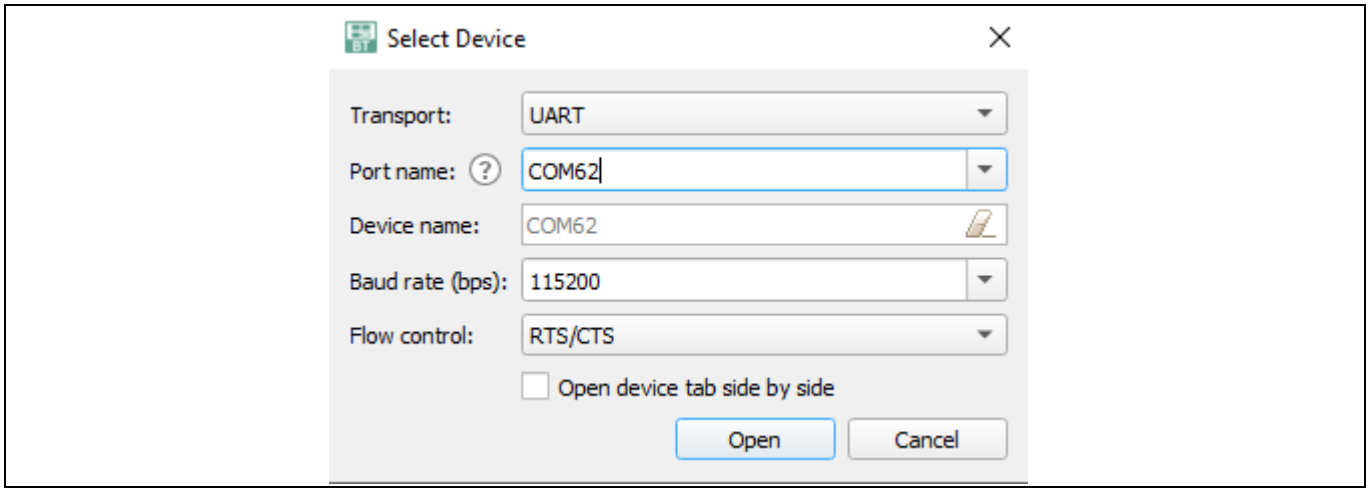

Figure 6 Select Device window

5. On the window that displays the list of HCI commands, under **7.3: Host Controller & Baseband Commands**, double-click **Reset**.

Download Bluetooth® firmware onto CYW920829M2EVK-02

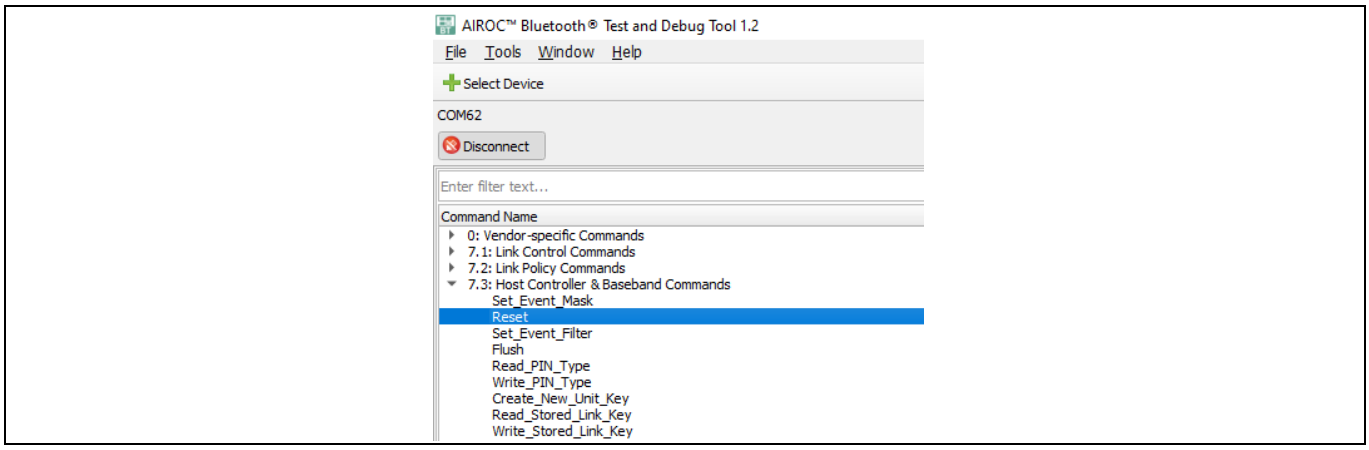

Figure 7 HCI Reset command

The log window should display the command entered and return with “Status = success”.

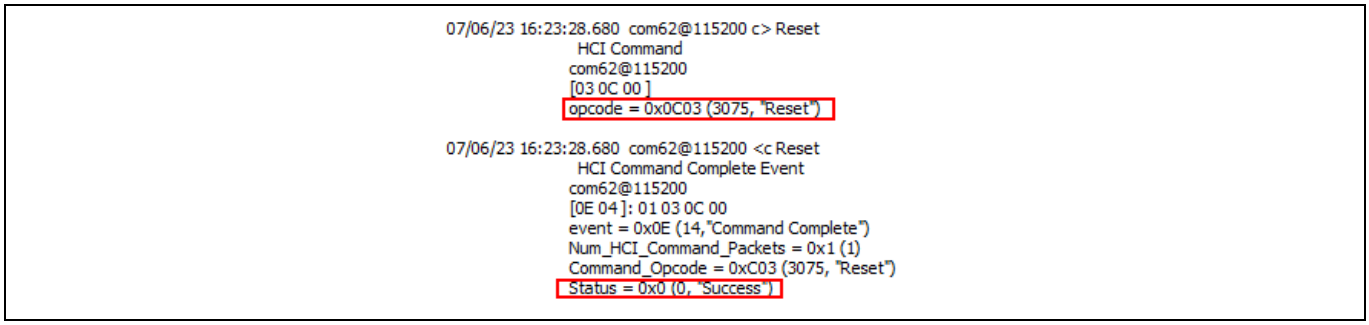

Figure 8 Status of HCI Reset command

6. Once the success message is shown in the log window, select **Tools > Program Device**.

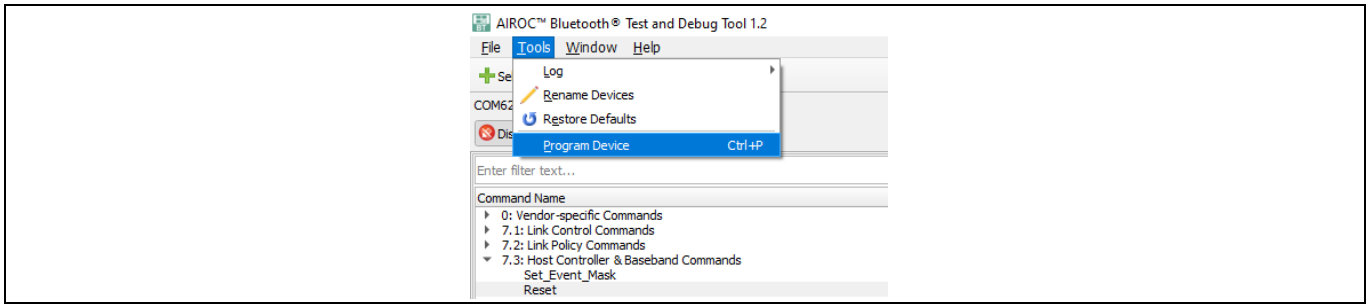

Figure 9 Program Device command

7. On the **Program Device** window that appears, enter the following and click **Program**. See Figure 10.
   - **Target device:** Select CYW20829/CYW555xx/CYW89570.
   - **Port:** Select the corresponding COM port.
   - **Baud rate (bps):** Select 115200.
   - Select the **Firmware** option and browse for the CYW20829 FW (.hex file).

Download Bluetooth® firmware onto CYW920829M2EVK-02

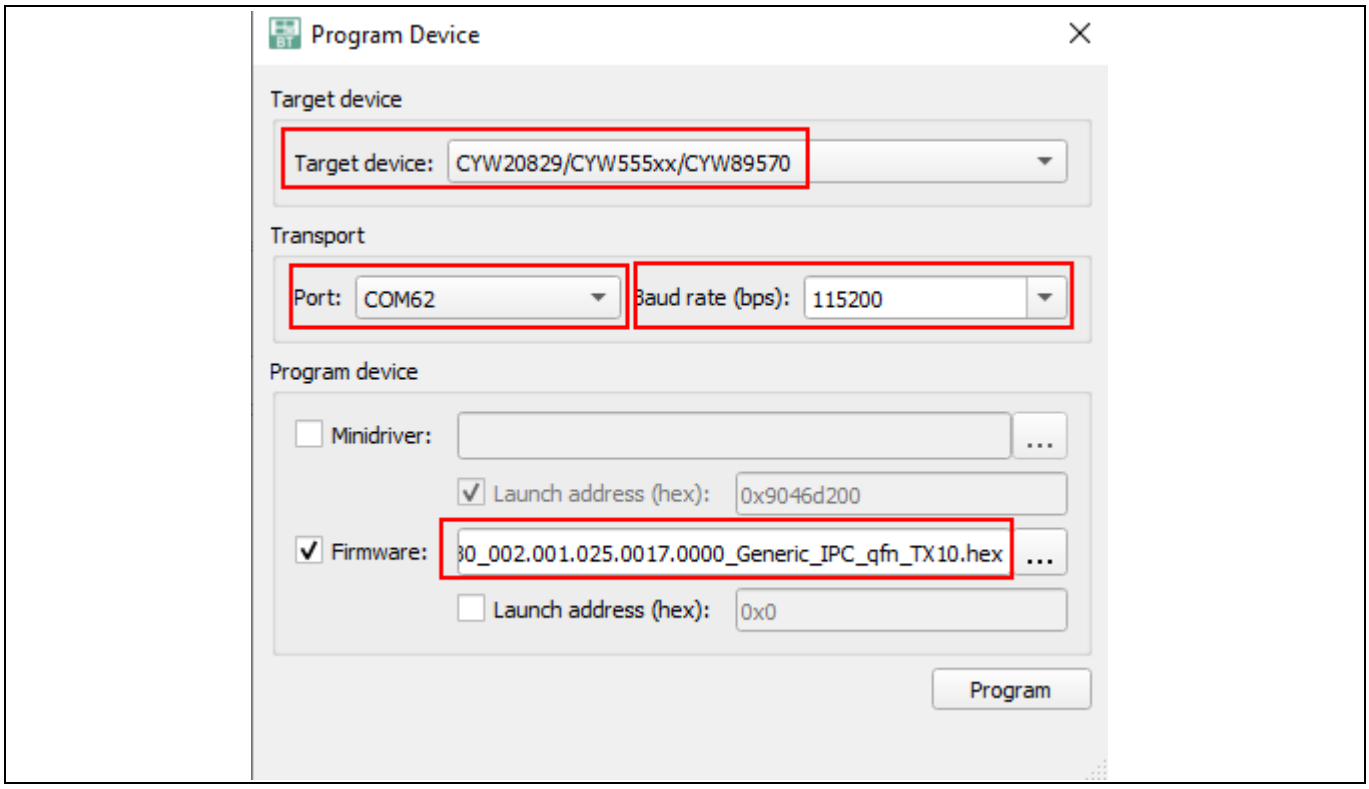

Figure 10 Program Device window

8. Click **OK** on the dialog box.

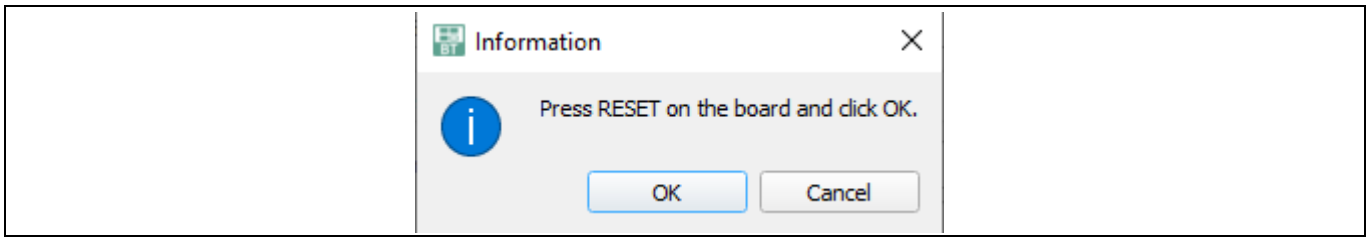

Figure 11 Program Device alert message

*Note: Ignore the message on the pop-up window shown in Figure 11 and **DO NOT** press RESET on the board.*

Programming should start and the status message should display “Completed successfully” on the bottom left corner of the **Program Device** pop-up window. Close the window when done.

Download Bluetooth® firmware onto CYW920829M2EVK-02

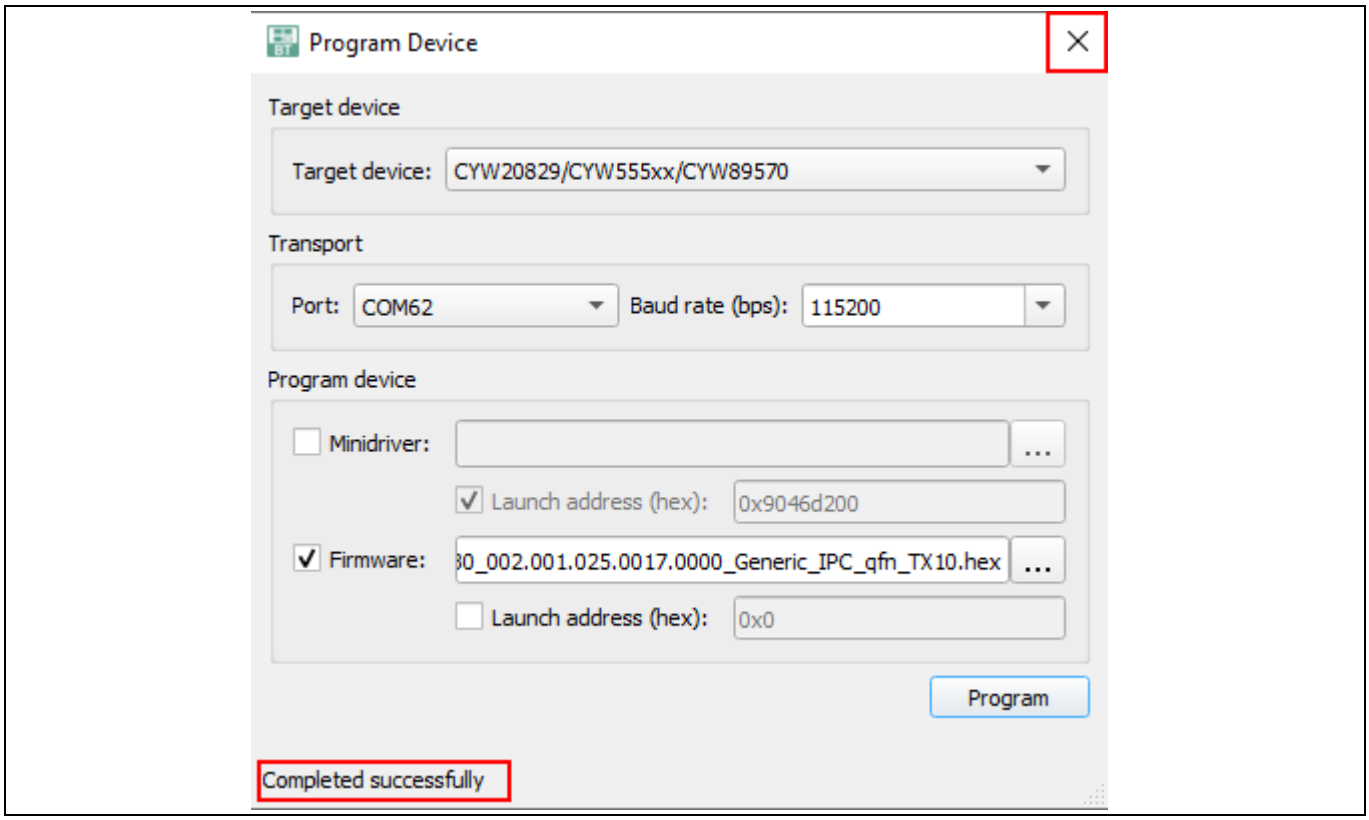

Figure 12 Program Device status

9. Note that the COM port will be closed during firmware download. After the download is completed, follow steps 3 - 5 to open the COM port again.
10. From the list of HCI commands, under **7.4: Informational Parameters**, double-click **Read_BD_ADDR**.

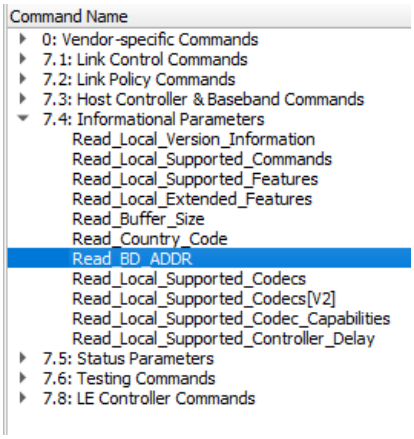

Figure 13 Read_BD_ADDR command

In the log, if you see a 12-digit BD_ADDR that starts with “20829B0”, that means the FW download is successful.

Download Bluetooth® firmware onto CYW920829M2EVK-02

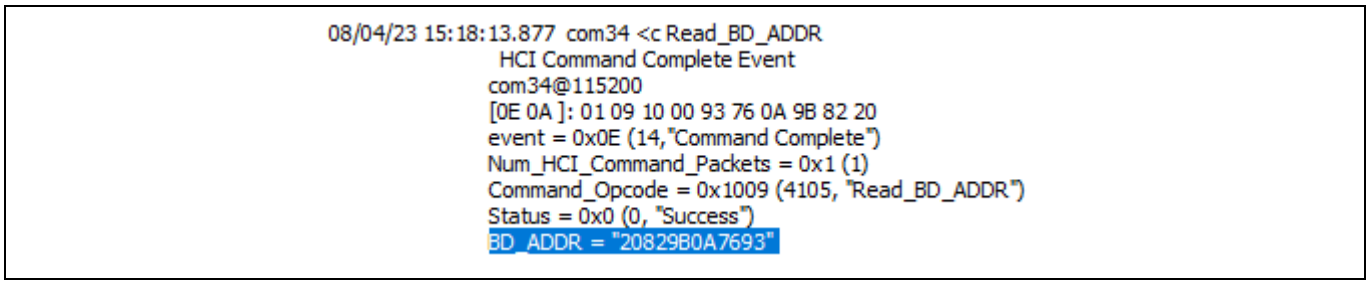

Figure 14 Read_BD_ADDR result

Note: Because the firmware download process stores the firmware in the RAM, if CYW920829M2EVK-02 loses power, you need to start over and download the HCI loading app and later download the firmware again.

4 Transmitter test

Do the following after you have downloaded the HCI loading app and firmware.

1. Under the command list **7.3: Host Controller & Baseband Commands**, double-click **Reset**, and check for the “success” status in the log window. (see Figure 9 and Figure 10).
2. In the HCI Command list, under **7.8: LE Controller Commands**, select **LE_Transmitter_Test_[V2]**.

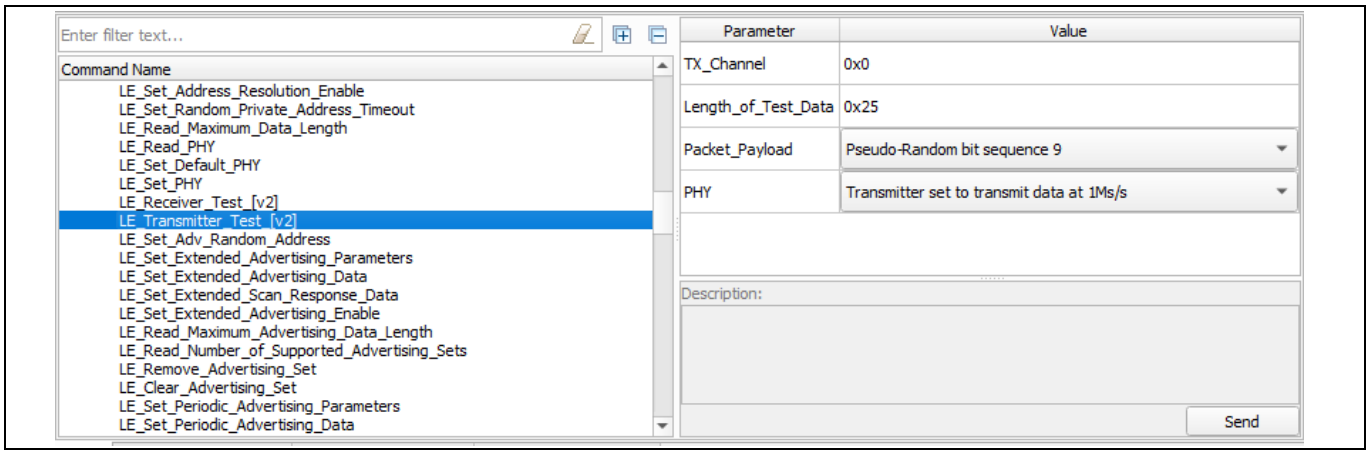

Figure 15 LE_Transmitter_Test_[V2] command

3. To transmit the data, on the parameter pane on the right, enter the following, and then click **Send**.
   - **TX_Channel**: Enter the desired channel number. Can be a decimal or hex value (0–39 or 0x0–0x27).
   - **Length_of_Test_data**: Enter the desired data length (up to 255 or 0xFF).
   - **Packet_Payload**: Use the drop-down menu and select the desired payload type.
   - **PHY**: Use the drop-down menu and select the desired PHY (1M, 2M, S2, or S8).
4. To stop transmitting, under **7.8: LE Controller Commands**, double-click **LE_Test_End**.

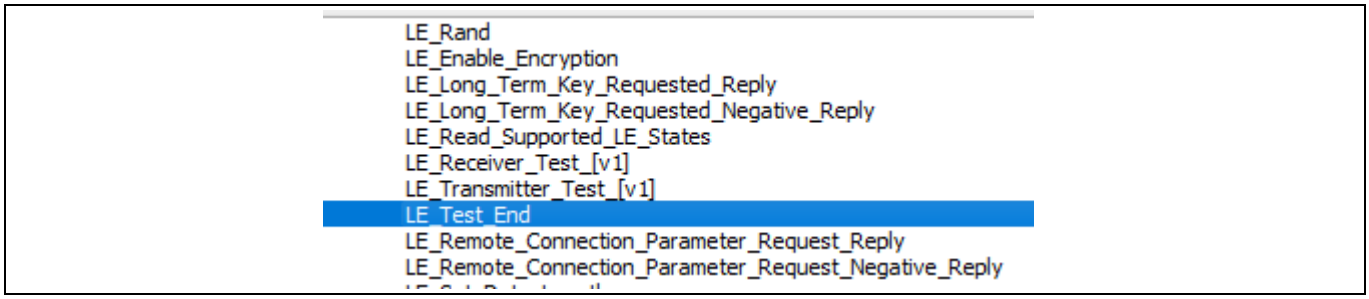

Figure 16 LE_Test_End command

5 Reading the RSSI

1. Connect two CYW920829M2EVK-02 kits to the PC and follow sections 2 and 3 to download the HCI loading app, and then download the firmware.
2. If both kits are programmed with the same firmware file (.hex), they will have the same BD address. To make a connection between the two kits, their BD address must be different. Therefore, you need to write a different BD Address to one of the kits. Do the following:
   a) For the device that you want to change the BD address of, under **0: Vendor-specific Commands**, click **Write_BD_ADDR**.
   b) On the parameter pane on the right, in the **Value** box, enter a different BD_ADDR, and then click **Send**.

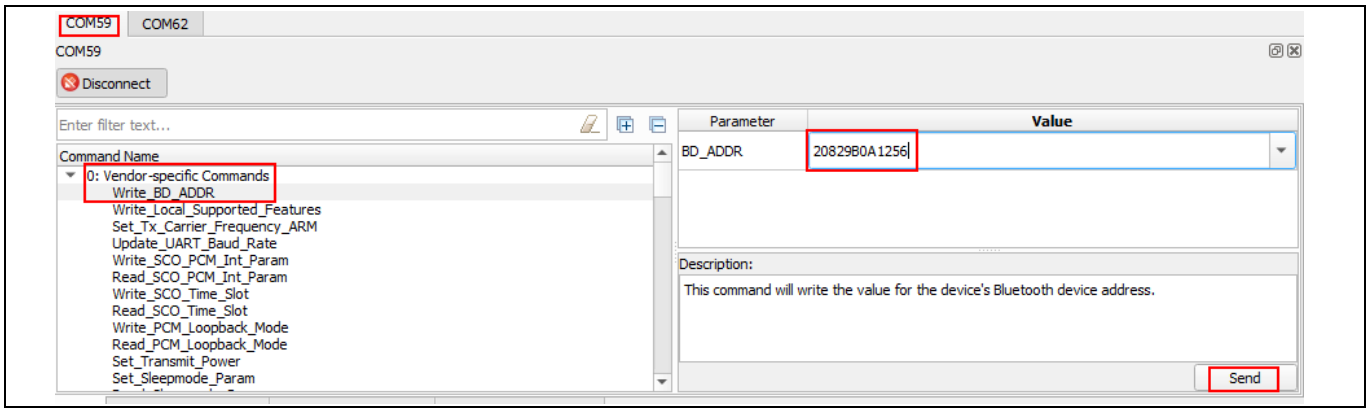

Figure 17 Write_BD_ADDR command

3. Make the first board as the peer device, and set it to advertising:
   a) Under **7.8: LE Controller Commands**, click **LE_Set_Extended_Advertising_Parameters**.
   b) On the parameter pane on the right, for **Parameters**, enter the following, and then click **Send**.
   - **Advertising_Event_Properties**: Select Connectable advertising.
   - **Peer_Address**: Enter the BD_Address of the other board (host).
   - **Secondary_Advertising_PHY**: Select LE 2M PHY.
   - Leave all other parameters at their default values.

Reading the RSSI

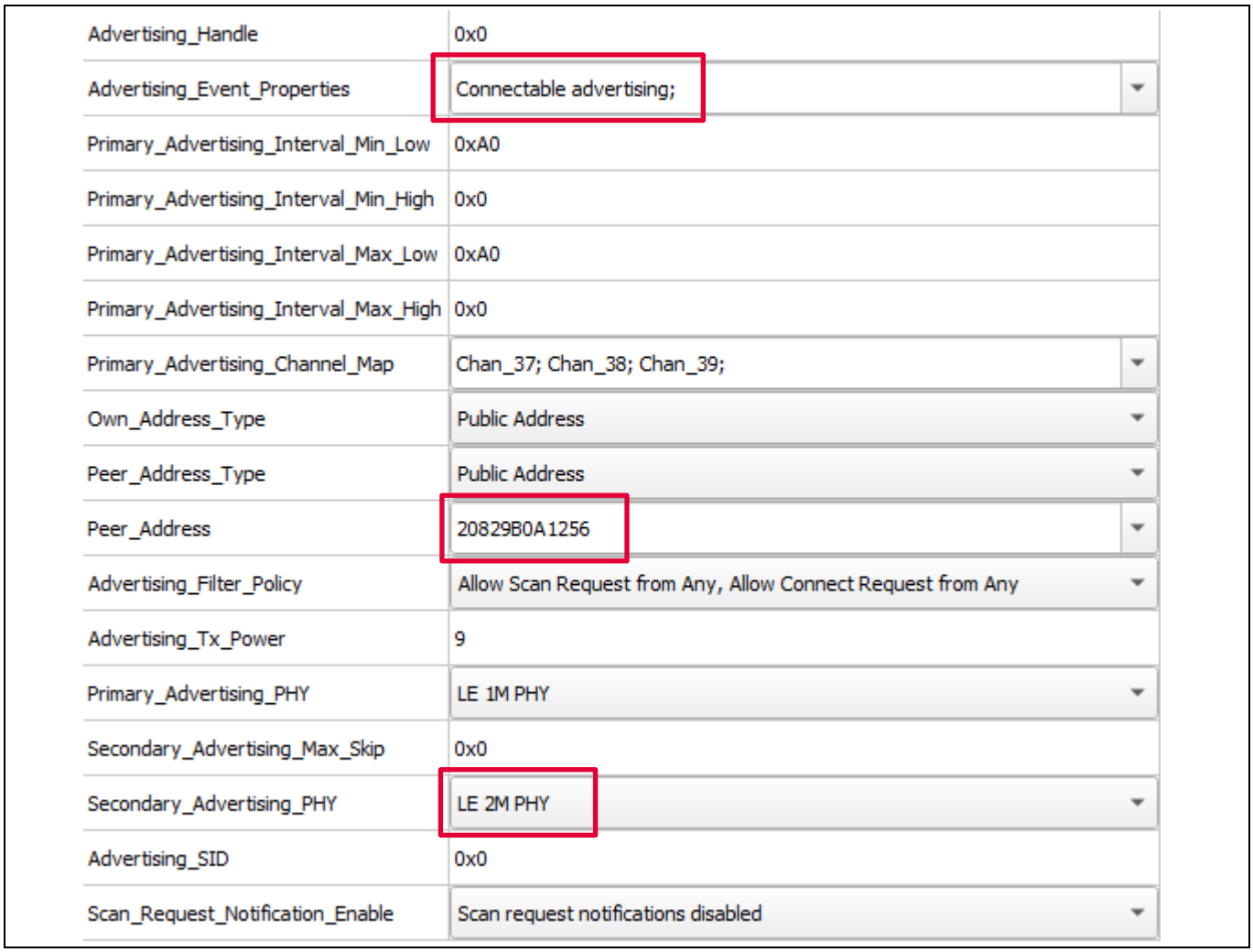

Figure 18 LE_Set_Extended_Advertising_Parameters command

4. After setting the advertising parameters, enable advertising. Under **7.8: LE Controller Commands**, click **LE_Set_Extended_Advertising_Enable**.
5. On the parameter pane on the right, configure the following parameters and then click **Send**. See Figure 18.
   - **Enable**: Select Advertising is enabled.
   - Leave all other parameters at their default values.

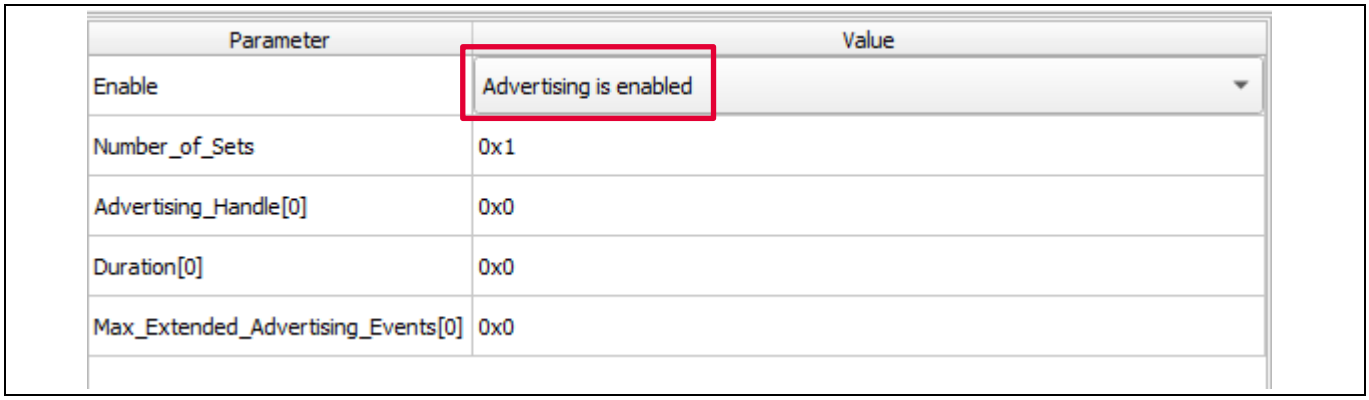

Figure 19 LE_Set_Extended_Advertising_Enable command

Reading the RSSI

6. Make the second kit as the host and initiate the connection. Under **7.8: LE Controller Commands**, click **LE_Extended_Create_Connection**.
   - On the parameter pane on the right, configure the following parameters and then click **Send**. See Figure 20.
   - **Peer_Address**: Enter the BD_Address of the other board (advertising board).
   - **Conn_Latency[0]**: Enter '0'.
   - **Supervision_Timeout[0]**: Enter "100" or "0x64".

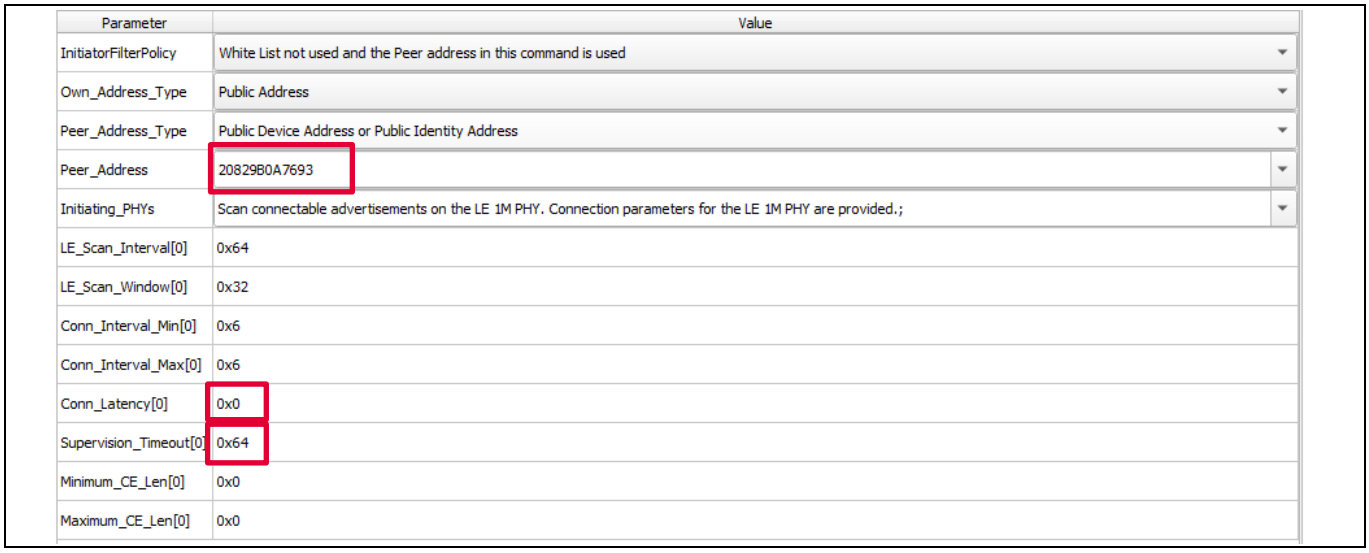

Figure 20 LE_Extended_Create_Connection command

If the connection is successful, the log window returns "Status = Success" with a connection handle as follows:

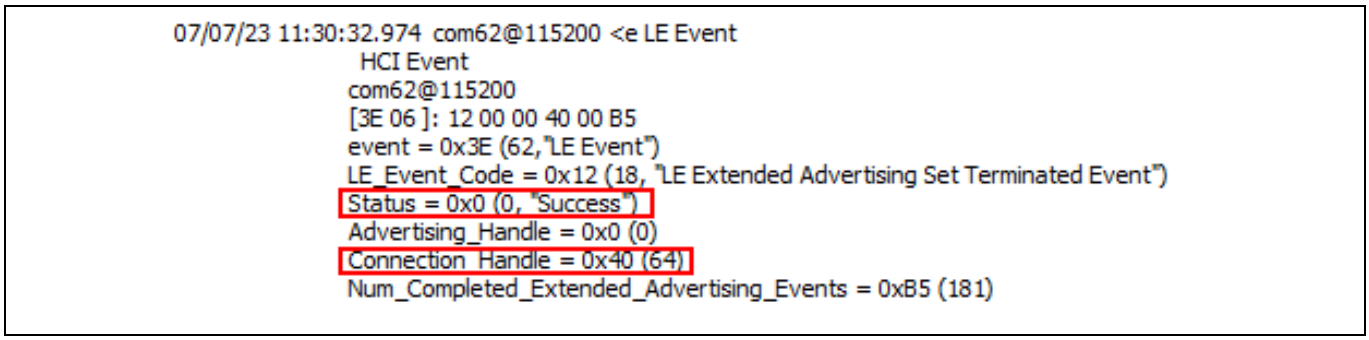

Figure 21 LE_Extended_Create_Connection command

7. After the connection is made, you can change the LE PHY (LE1M, LE2M, S2, or S8). Under **7.8: LE Controller Commands**, click **LE_Set_PHY**.

Reading the RSSI

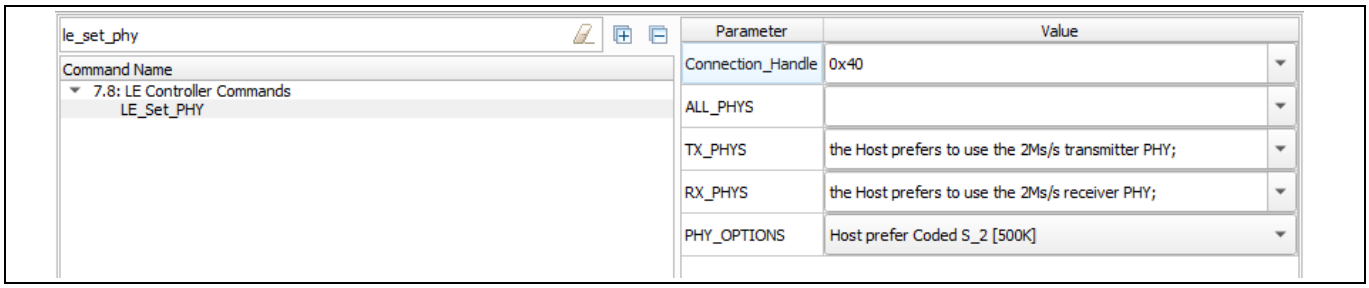

Figure 22 LE_Set_PHY command

8. On the parameter pane on the right, configure the following:
   - **Connection_Handle**: Set to the same connection handle as Step 6. This field should be auto-populated if the connection is made successfully.
   - **ALL_PHYS**: Leave as blank.
   - **TX_PHYS**: Select the desired PHY (1Ms/s, 2Ms/s or Coded).
   - **RX_PHYS**: Select the desired PHY (1Ms/s, 2Ms/s or Coded).

Note: For testing purposes, TX_PHYS and RX_PHYS must be set to the same value.

   - **PHY_OPTIONS**: Select either **Coded S_2** or **Coded S_8**. This parameter will be ignored if **TX_PHYS** or **RX_PHYS** is set to 1Ms/s or 2Ms/s.
9. Repeat this command again with different parameters to test with different values for LE_PHY.
10. To read the RSSI, under **7.5: Status Parameters**, click **Read_RSSI**.
11. On the parameter pane on the right, select the corresponding connection handle, and then click **Send**.

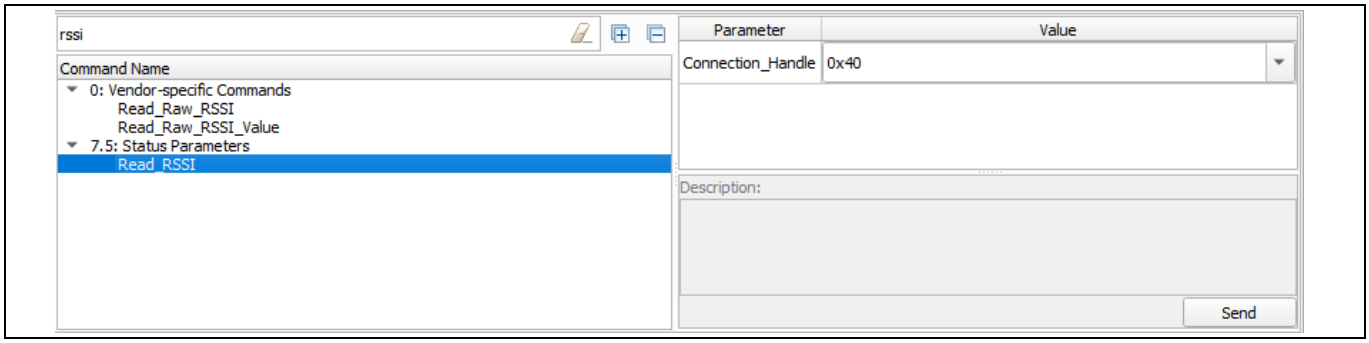

Figure 23 Read_RSSI command

The log window should return the RSSI value as follows:

Reading the RSSI

```
07/07/23 11:57:27.530  com59@115200 c> Read_RSSI
                        HCI Command
                       com59@115200
                       [05 14 02]: 40 00
                       opcode = 0x1405 (5125, "Read_RSSI")
                       Connection_Handle = 0x40 (64)

07/07/23 11:57:27.530  com59@115200 <c Read_RSSI
                        HCI Command Complete Event
                       com59@115200
                       [0E 07]: 01 05 14 00 40 00 BC
                       event = 0x0E (14,"Command Complete")
                       Num_HCI_Command_Packets = 0x1 (1)
                       Command_Opcode = 0x1405 (5125, "Read_RSSI")
                       Status = 0x0 (0, "Success")
                       Connection_Handle = 0x40 (64)
                       RSSI = 0xBC (-68, dB)
```

Figure 24 Result of the Read_RSSI command

6 Receiver sensitivity test

This method is used in Bluetooth® Qualification Body (BQB) testing. In this method, a Bluetooth® tester (such as the Rohde & Schwarz CMW270 tester used in this document) sends 1500 packets at a certain power level. The AIROC™ CYW20829 device will receive the packets and report the number of packets received.

1. Connect a CYW920829M2EVK-02 kit to the PC.
2. Follow sections 2 and 3 to download the HCI loading app and firmware.
3. Connect the RF port to a Bluetooth® tester.
4. In the **HCI Command** menu, under **7.8: LE Controller Commands**, select **LE_Receiver_Test_[V2]**.

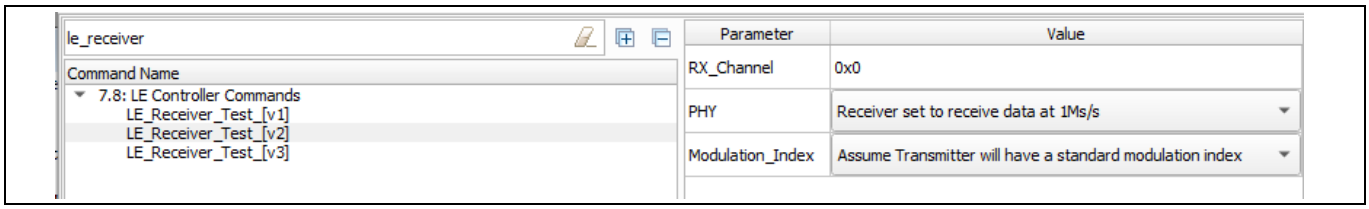

Figure 25 LE_Receiver_Test_[V2] command

5. On the parameter pane on the right, configure the following, and then click **Send**.
   - **RX_Channel**: Select the desired channel. Can be in decimal or hex value (0–39 or 0x0–0x27).
   - **PHY**: Select the desired LE PHY. 1Ms/s, 2MS/s or Coded PHY. The 'Coded PHY' option can be used for both S2 and S8.
   - **Modulation_Index**: Select the standard or stable modulation index.
6. On the Bluetooth® tester, start transmitting the packets at a given Tx power. See the documentation of the tester to learn how to start transmission.
7. After the packets are transmitted, double-click **LE_Test_End** under **7.8: LE Controller Commands**.

   The log window will display the number of packets received by the CYW20829 device.

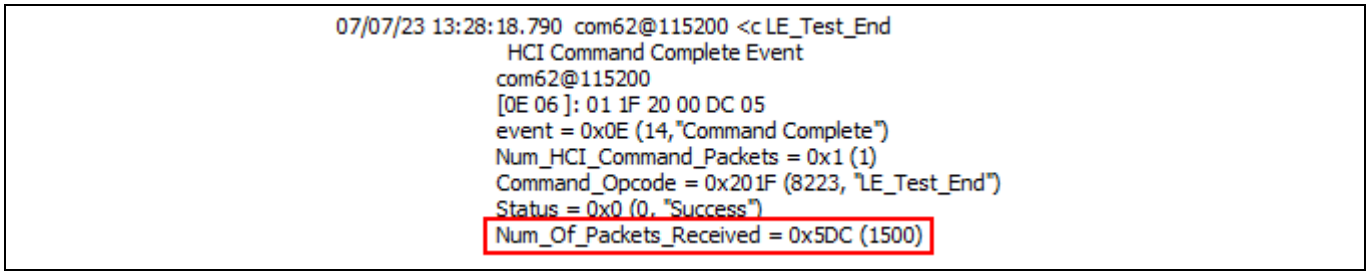

Figure 26 Log window displaying the number of packets received

8. Calculate the packet error rate (PER) using the following equation:

   PER = (Number of packets sent – Number of packets received) / Number of packets sent.

9. Repeat steps 6 to 8, but decrease the Tx power from the tester until you observe **30.8% PER**. This determines the sensitivity level.

References

See the following documents for more information:

[1] Infineon Technologies AG, *CYW20829, AIROC™ Bluetooth® LE 5.4 MCU*; Available online

[2] Open On-Chip Debugger (OpenOCD); *OpenOCD v0.12.0 user guide*; Available online

[3] Infineon Technologies AG, *ModusToolbox™ tools package installation guide*; Available online

Revision history

Document revision	Date	Description of changes
**	2023-08-18	Initial release

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