Throughput testing for AIROC™ CYW20829 on AIROC™ Bluetooth® Test and Debug Tool

About this document

This application note contains instructions for using the AIROC™ Bluetooth® Test and Debug Tool for testing the throughput between two AIROC™ CYW20829 Bluetooth® LE MCU devices. There are various parameters set throughout the test setup that can be adjusted according to the metric being measured. The parameters used in this application note match those used in various blogs posted on Infineon Community.

Intended audience

Developers interested in testing the throughput performance of the AIROC™ CYW20829 Bluetooth® LE MCU.

Table of contents

About this document **1**
Table of contents **2**
1 Introduction **3**
2 Throughput testing **5**
2.1 Software requirements 5
2.2 Hardware requirements 5
2.3 Download Bluetooth® firmware 5
2.4 Transport setup 6
2.5 Reset the DUT 7
2.6 Update the UART baud rate 8
2.7 Set up Bluetooth® connection 11
2.8 Set PHY 15
2.9 Set Data 20
3 Test throughput **24**
Revision history **29**
Disclaimer **30**

1 Introduction

Throughput measurements on a given device depend on a variety of connection parameters. These connection parameters are set via AIROC™ Bluetooth® Test and Debug Tool and define the PHY, connection intervals, packet sizes, and more for a given connection. Table 1 describes some of the parameters that can be set on the AIROC™ Bluetooth® Test and Debug Tool.

Table 1 Connection parameters

Parameters	Description
LE_Set_Extended_Advertising_Parameters	
Advertising_Handle	A controller handle assigned by the Host to identify a new advertising set
Advertising_Event_Properties	Describes the type of advertising event that is being configured and its basic properties
Peer_Address	Device or Identity Address of the device to be connected
Primary_Advertising_PHY	Indicates the PHY on which the advertising packets are transmitted on the primary advertising physical channel
Secondary_Advertising_PHY	Indicates the PHY on which the advertising packets are to be transmitted on the secondary advertising physical channel
LE_Extended_Create_Connection	
Initiating_PHYs	Indicates the PHY(s) on which the advertising packets should be received on the primary advertising physical channel and the PHYs for which connection parameters have been specified
LE_Scan_Interval	Recommendation from the Host on how frequently the Controller should scan; defined as the time interval from when the Controller started its last LE scan until it begins the subsequent LE scan
LE_Scan_Window	Recommendation from the Host on how long the Controller should scan
Conn_Interval_Min	Minimum value for the connection interval; connection interval is defined as the time from the beginning of one connection event to the beginning of the subsequent connection event
Conn_Interval_Max	Maximum value of the connection interval; connection interval is defined as the time from the beginning of one connection even to the beginning of the subsequent connection event
Conn_Latency	
Supervision_Timeout	The maximum amount of time without a connection event before the connection is considered lost

Parameters	Description
LE_Set_PHY	
Connection_Handle	A handle assigned by the Controller when a new logical transport is created or reserved and reported to the Host
TX_PHYS	Transmitter PHY that the Host prefers the Controller to use
RX_PHYS	Receiver PHY that the Host prefers the Controller to use
PHY_OPTIONS	Specifies the options for PHYs
LE_Set_Data_Length	
Connection_Handle	A handle assigned by the Controller when a new logical transport is created or reserved and reported to the Host
TxOctets	Preferred maximum number of payload octets that the local Controller should include in a single LL Data PDU on the connection specified in the Connection_Handle parameter
TxTime	Preferred maximum number of microseconds that the local Controller should use to transmit a single Link Layer packet containing an LL Data PDU on the connection handle specified in the Connection_Handle parameter

2 Throughput testing

This section provides instructions on how to test the throughput between two CYW20829 devices using the AIROC™ Bluetooth® Test and Debug Tool.

The AIROC™ Bluetooth® Test and Debug Tool is a standalone, cross-platform tool for testing and debugging AIROC™ Bluetooth® devices. The tool communicates with Bluetooth® devices through a Host/Controller Interface (HCI) and supports UART and USB physical interfaces.

2.1 Software requirements

AIROC™ Bluetooth® Test and Debug Tool (version 1.3.x)

For Windows, Linux or MacOS, you can download the tool directly from here.

or

You can download the tool from Infineon Developer Center.
In Infineon Developer Center, search for AIROC™ Bluetooth® Test and Debug Tool and install version 1.3.x.



Figure 1 Infineon Developer Center window

2.2 Hardware requirements

- Two AIROC™ CYW20829 Bluetooth® LE MCU devices
- One or two PCs to send HCI commands to your CYW20829 devices

2.3 Download Bluetooth® firmware

Download firmware onto both CYW20829 devices.
Refer to CYW20829 manufacturing flow (AN239869) for instructions on how to download Bluetooth® firmware onto CYW20829 for RF testing.

2.4 Transport setup

1. Connect each AIROC™ CYW20829 Bluetooth® LE MCU device to a PC.
2. For each device, open AIROC™ Bluetooth® Test and Debug Tool and click **Select Device**.

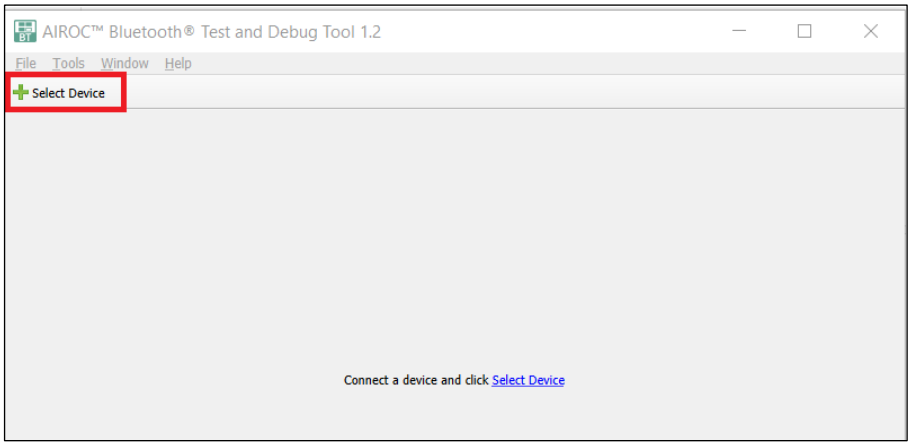

Figure 2 AIROC™ Bluetooth® Test and Debug Tool window

Note: In the case that both devices are connected to the same PC, open a second instance of AIROC™ Bluetooth® Test and Debug Tool on the PC for your second device.

3. For each instance of AIROC™ Bluetooth® Test and Debug Tool, make the following changes and then click **Open**.

- **Transport:** UART
- **Port name:** Select the appropriate COM PORT
- **Baud rate:** 115200
- **Flow control:** RTS/CTS

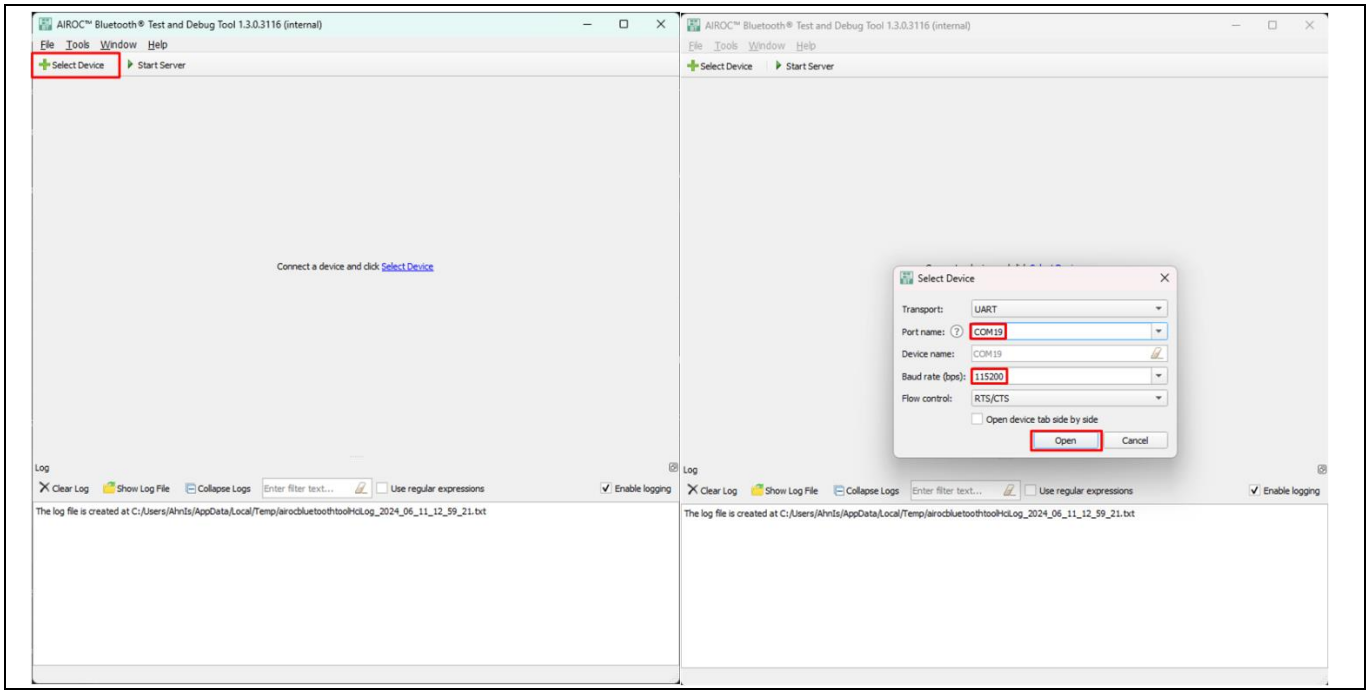

Figure 3 Open COM port

If you are unable to connect to the DUT, check the following before trying again:

- Ensure that no other application uses the port used by the DUT
- Verify that the correct port name is entered

2.5 Reset the DUT

This section applies to both instances of AIROC™ Bluetooth® Test and Debug Tool. This test verifies that the device is correctly configured and connected to the PC.

1. Search **Reset** in the search text box.
2. Double-click **Reset** or select **Reset** and then click the **Send** button on the right to issue the HCI reset command.

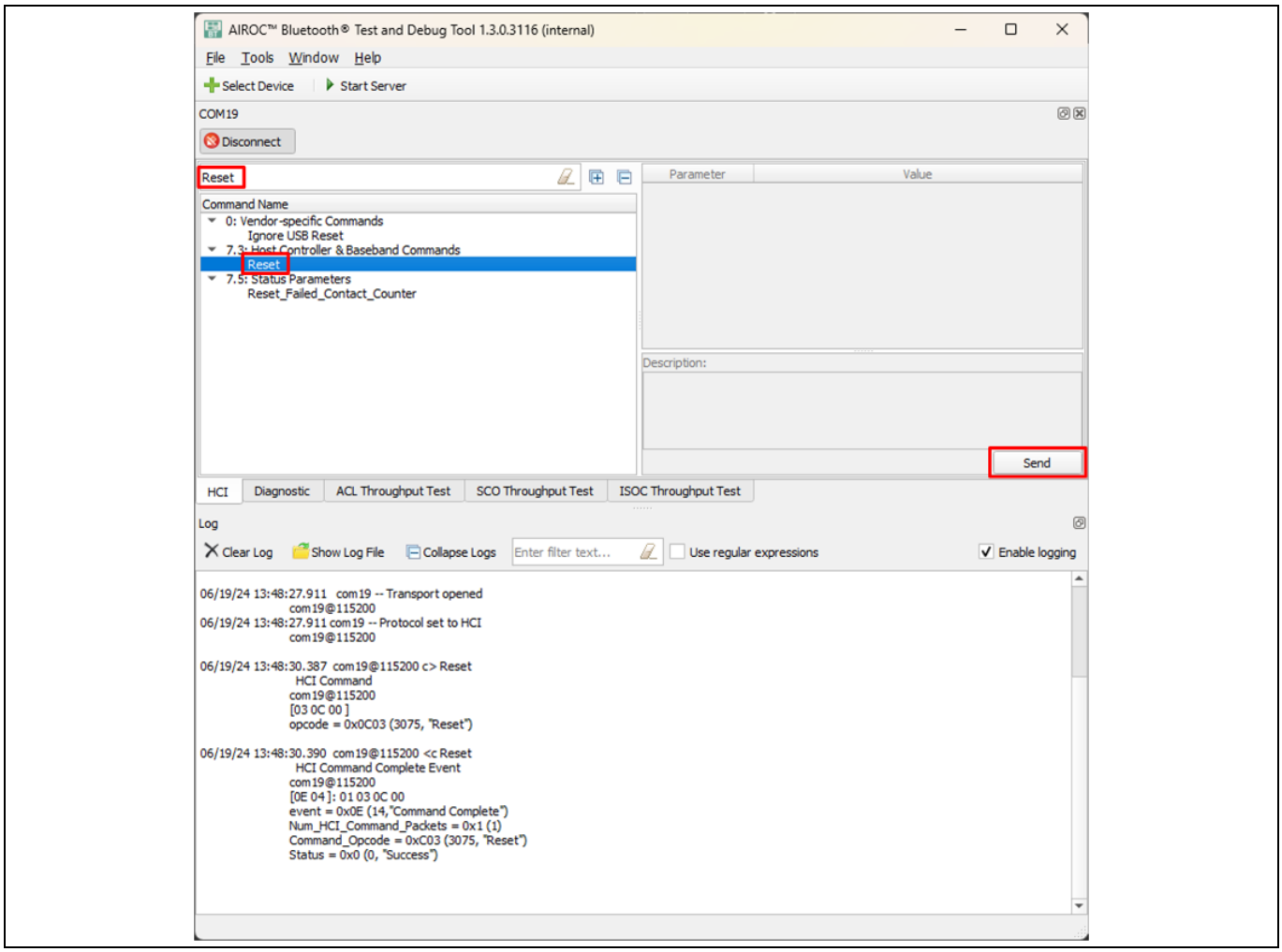

Figure 4 Reset the DUT

If there are no issues in the UART transport, you should receive a reply from the controller with the “Success” status code in the HCI log window.

2.6 Update the UART baud rate

This section applies to both instances of AIROC™ Bluetooth® Test and Debug Tool.

1. Send HCI command **Update_UART_Baud_Rate** with the parameters below:

- **Baud_Rate:** 3000000

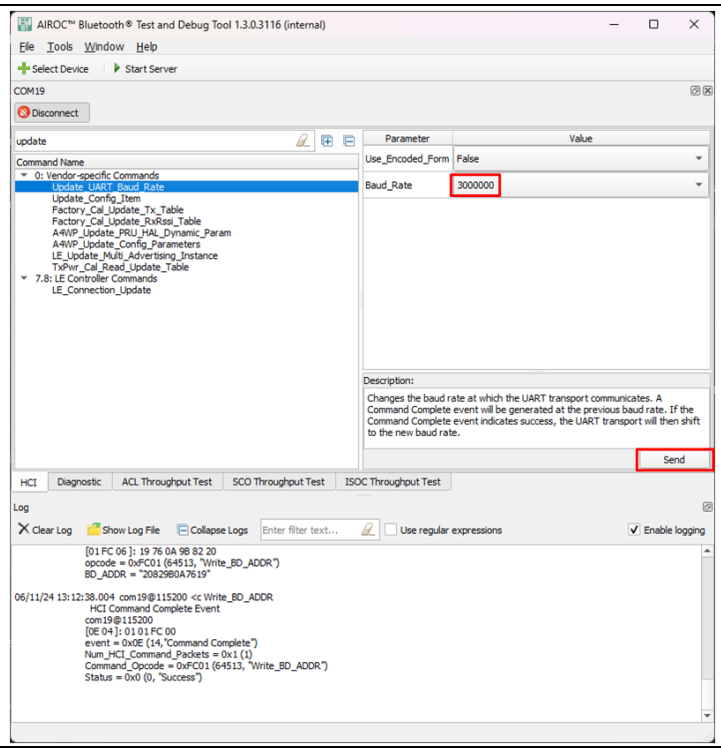

Figure 5 Update baud rate

If there are no issues in the UART transport, you should receive a reply from the controller with the “Success” status code in the HCI log window.

2. Once the baud rate is updated, disconnect and close your COM PORT, then re-open your COM PORT using the updated baud rate of 3000000.

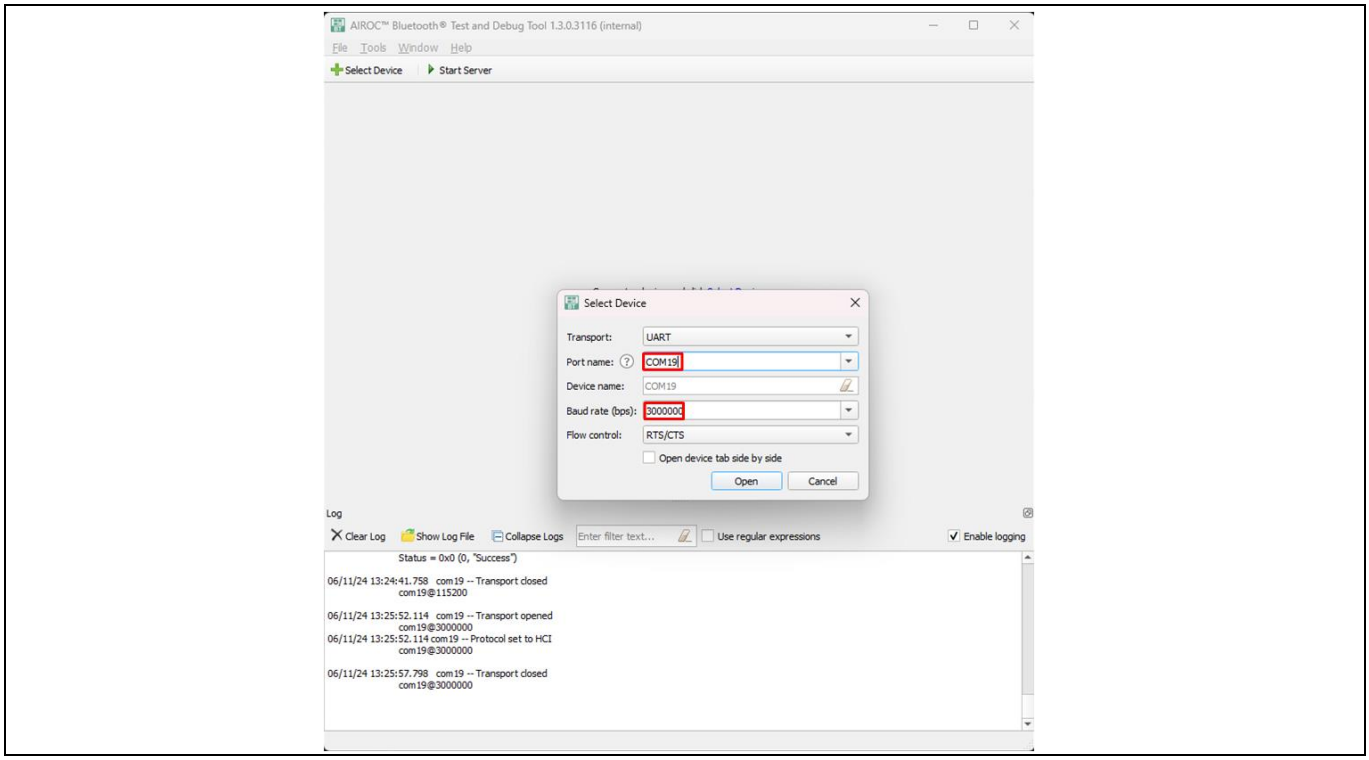

Figure 6 Reconnect with updated baud rate

2.7 Ensure BD addresses do not match

Choose one of your devices on which to change the BD address

On one device, perform the following steps:

1. Search **Write** in the Search text box on AIROC™ Bluetooth® Test and Debug Tool.
2. Select the **Write_BD_ADDR** command in the **Command Name** tab.
3. On the right window, set the following parameter, then click **Send**.

- **BD_ADDR:** Choose an appropriate BD address that does not match the BD address of your other device.

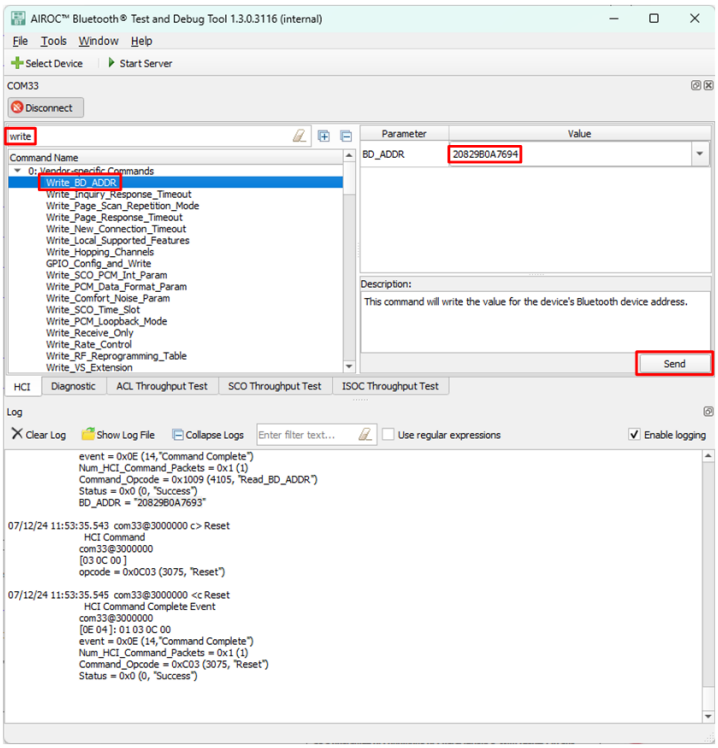

Figure 7 Write_BD_ADDR

2.8 Set up Bluetooth® connection

Choose one of your two devices to be the transmitter and the other to be the receiver.

For the transmitter device, perform the following steps:

1. Search **LE_Set_Extended** in the Search text box on AIROC™ Bluetooth® Test and Debug Tool.
2. Select the **LE_Set_Extended_Advertising_Parameters** command in the **Command Name** tab.
3. On the right window, set the following parameters, and click **Send**.

- **Advertising_Handle:** 0x40
- **Advertising_Event_Properties:** Connectable advertising;
- **Peer_Address:** Select the appropriate address (see note below)
- **Primary_Advertising_PHY:** LE 1M PHY
- **Secondary_Advertising_PHY:** LE 1M PHY

*Note: The **Peer_Address** parameter should be set to the BD address of the receiver device.*

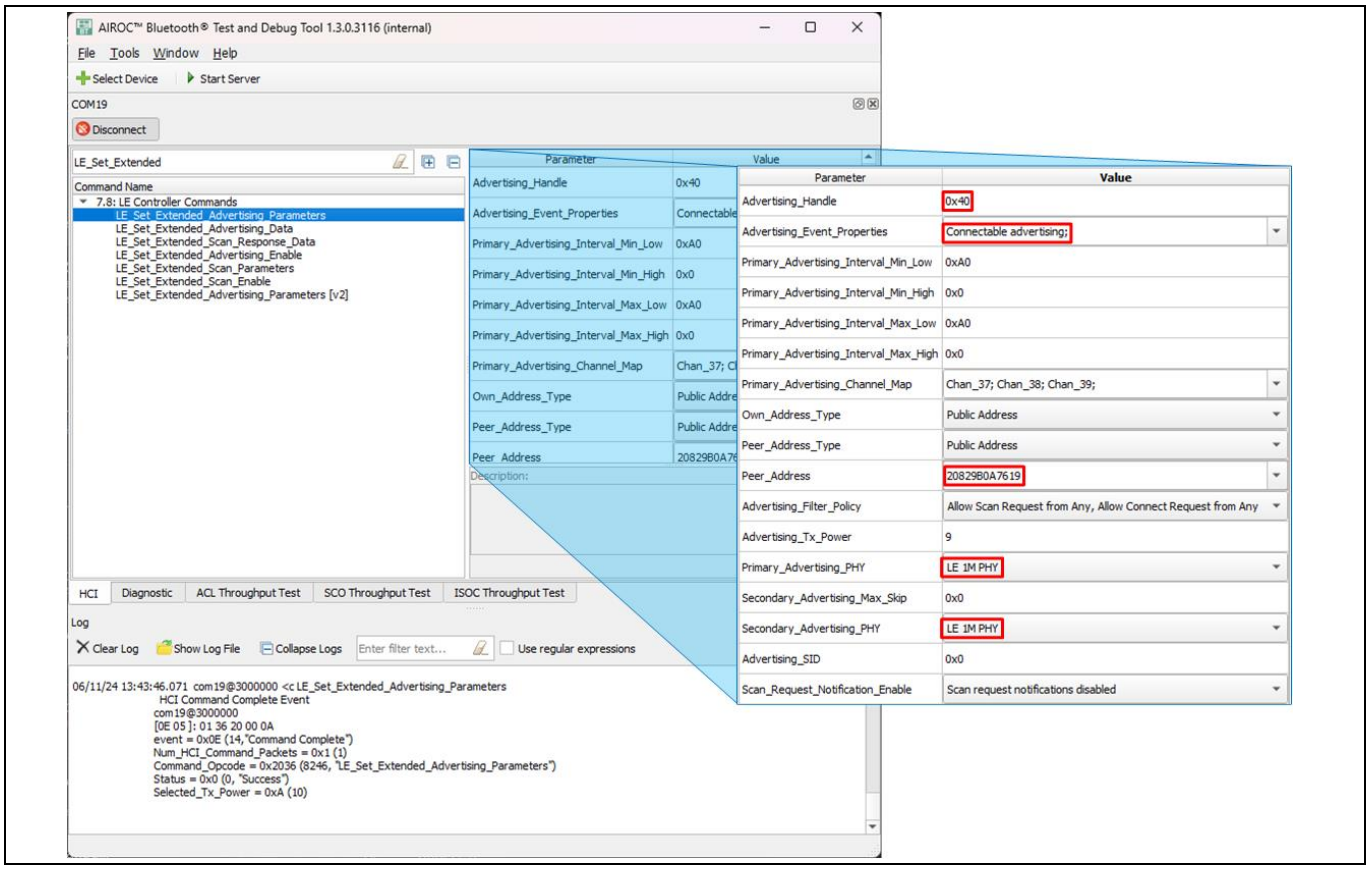

Figure 8 LE_Set_Extended_Advertising_Parameters

4. Select the **LE_Set_Extended_Advertising_Enable** command in the **Command Name** tab.
5. On the right window, set the following parameters, and click **Send**.

- **Enable:** Advertising is enabled
- **Advertising_Handle[0]:** 0x40

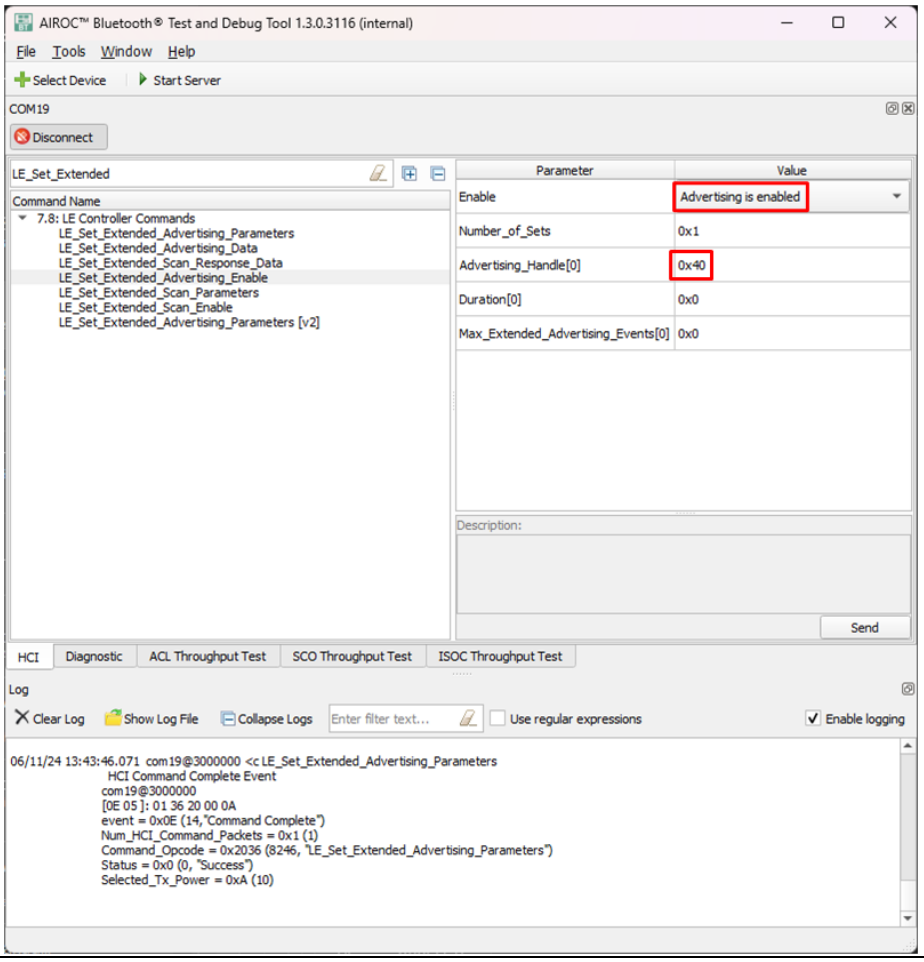

Figure 9 LE_Set_Extended_Advertising_Enable

For the receiver device, perform the following steps:

1. Search **LE_Extended** in the search text box.
2. Select the **LE_Extended_Create_Connection** command.
3. On the right window, set the following parameters, and click **Send**.

- **Peer_Address:** Select the appropriate address (see note below)
- **LE_Scan_Interval[0]:** 0xA0
- **LE_Scan_Window[0]:** 0xA0
- **Conn_Interval_Min[0]:** 0x32
- **Conn_Interval_Max[0]:** 0x32
- **Conn_Latency[0]:** 0x0
- **Supervision_Timeout[0]:** 0x64

*Note: The **Peer_Address** parameter should be set to the BD address of the transmitter device.*

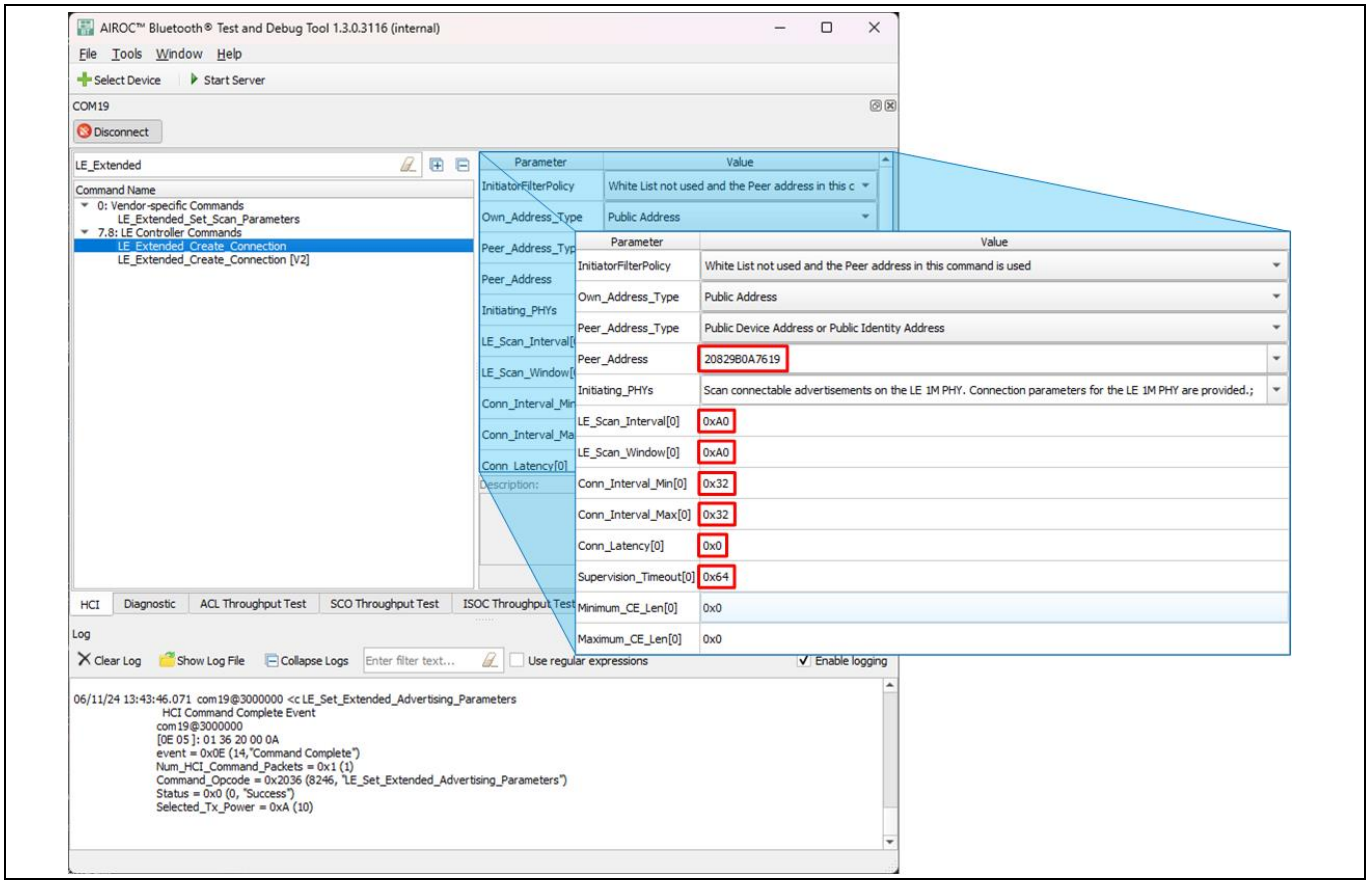

Figure 10 LE_Extended_Create_Connection command window

Once this command is sent, a connection should be created between the two devices. Once the connection is created, a message should appear on the log as shown in Figure 11.

```
06/11/24 16:19:27.832  com19@3000000 <e LE Event
                        HCI Event
                       com19@3000000
                       [3E 04 ]: 14 40 00 01
                       event = 0x3E (62,"LE Event")
                       LE_Event_Code = 0x14 (20, "LE Channel Selection Algorithm Event")
                       Connection_Handle = 0x40 (64)
                       Channel_Selection_Algorithm = 0x1 (1, "LE Channel Selection Algorithm #2 is used")

06/11/24 16:19:27.833  com22@3000000 <e LE Event
                        HCI Event
                       com22@3000000
                       [3E 04 ]: 14 40 00 01
                       event = 0x3E (62,"LE Event")
                       LE_Event_Code = 0x14 (20, "LE Channel Selection Algorithm Event")
                       Connection_Handle = 0x40 (64)
                       Channel_Selection_Algorithm = 0x1 (1, "LE Channel Selection Algorithm #2 is used")

06/11/24 16:19:27.833  com19@3000000 <e LE Event
                        HCI Event
                       com19@3000000
                       [3E 06 ]: 12 00 40 40 00 22
                       event = 0x3E (62,"LE Event")
                       LE_Event_Code = 0x12 (18, "LE Extended Advertising Set Terminated Event")
                       Status = 0x0 (0, "Success")
                       Advertising_Handle = 0x40 (64)
                       Connection_Handle = 0x40 (64)
                       Num_Completed_Extended_Advertising_Events = 0x22 (34)
```

Figure 11 Device connection confirmation message

2.9 Setting PHY

Some of the parameters for the following commands will depend on the PHY to be used for testing.

For both the transmitter and receiver devices:

1. Search **LE_Read_Remote** in the **Search** text box.
2. Select the **LE_Remote_Used_Features** command in the **Command Name** tab.
3. On the right winow, set the following parameters, and click **Send**.

- **Connection_Handle:** 0x40

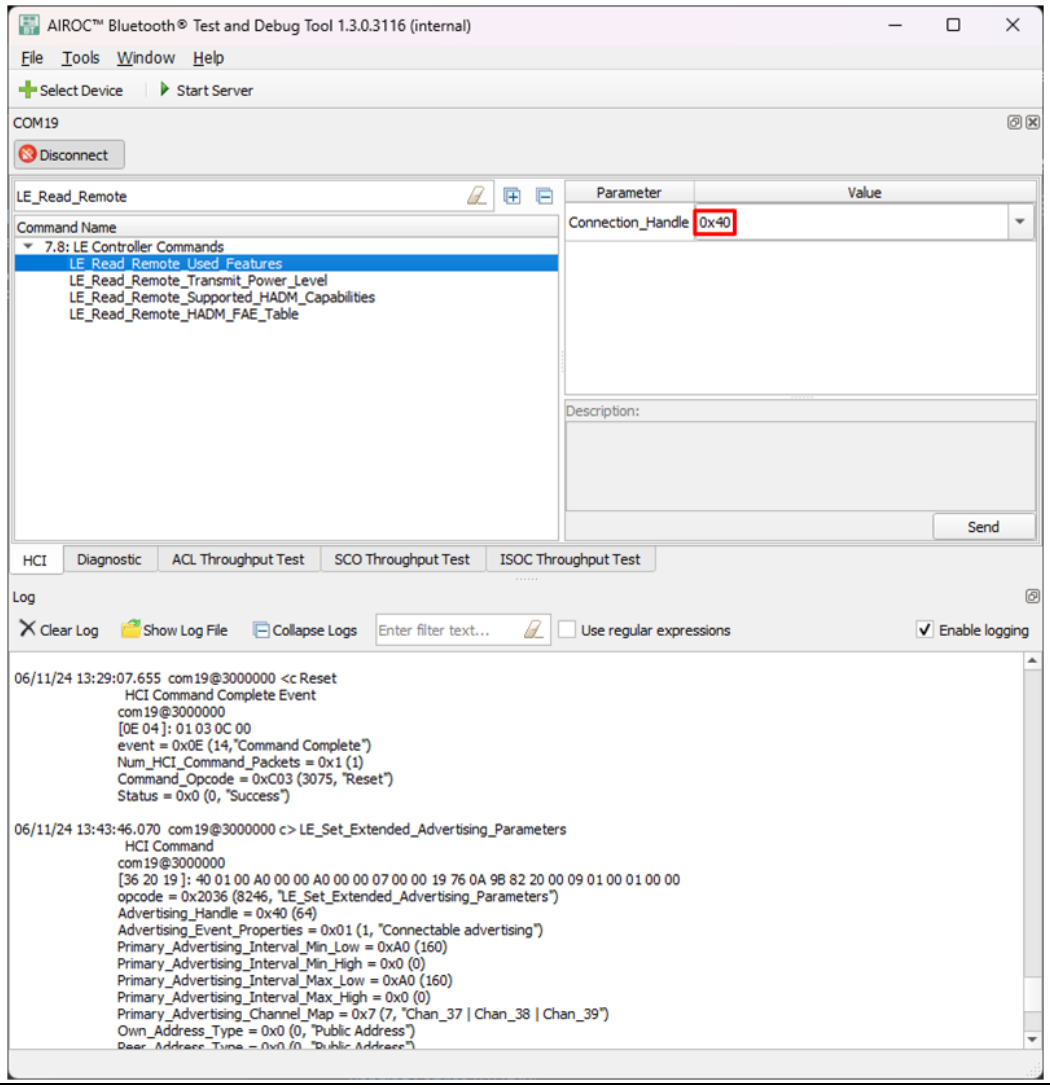

Figure 12 LE_Remote_Used_Features command window

To set LE 1M PHY, do the following for both the transmitter and receiver:

1. Search **LE_Set_PHY** in the **Search** text box.
2. Select the **LE_Set_PHY** command in the **Command Name** tab.
3. On the right window, set the following parameters, and click **Send**

- **Connection_Handle:** 0x40
- **TX_PHYS:** the Host prefers to use the 1M/s transmitter PHY;
- **RX_PHYS:** the Host prefers the use the 1M/s receiver PHY;
- **PHY_OPTIONS:** Host has no preference on Coded PHY

If successful, you will receive the “Success” status code in the HCI response packet from the DUT.

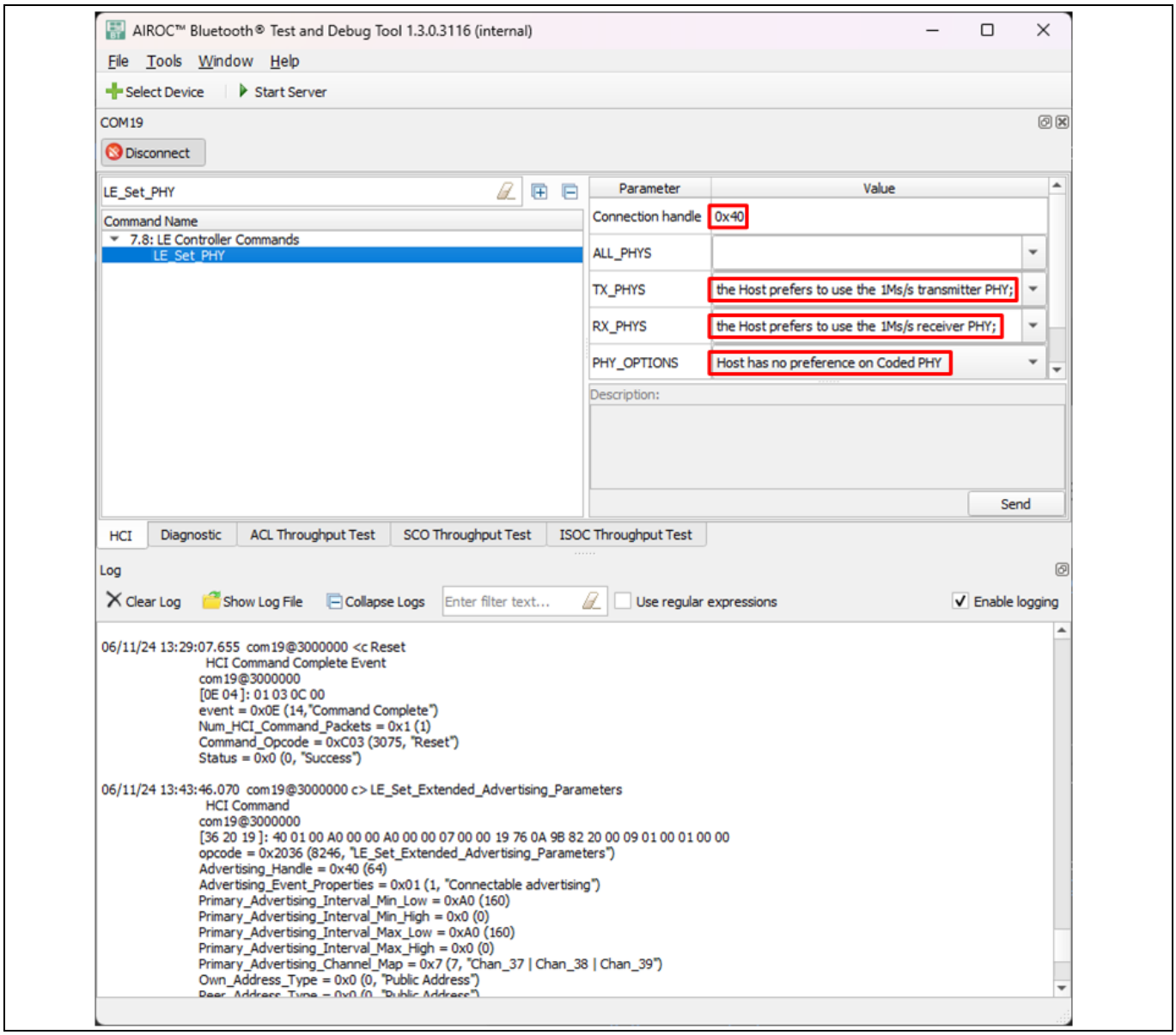

Figure 13 LE 1M LE_Set_PHY command window

To set LE 2M PHY, perform the following steps on both the transmitter and receiver:

1. Search **LE_Set_PHY** in the **Search** text box.
2. Select **LE_Set_PHY** command in the **Command Name** tab.
3. On the right window, set the following parameters, and click **Send**.

- **Connection handle:** 0x40
- **TX_PHYS:** the Host prefers to use the 2M/s transmitter PHY;
- **RX_PHYS:** the Host prefers the use the 2M/s receiver PHY;
- **PHY_OPTIONS:** Host has no preference on Coded PHY

If successful, you will receive the “Success” status code in the HCI response packet from the DUT.

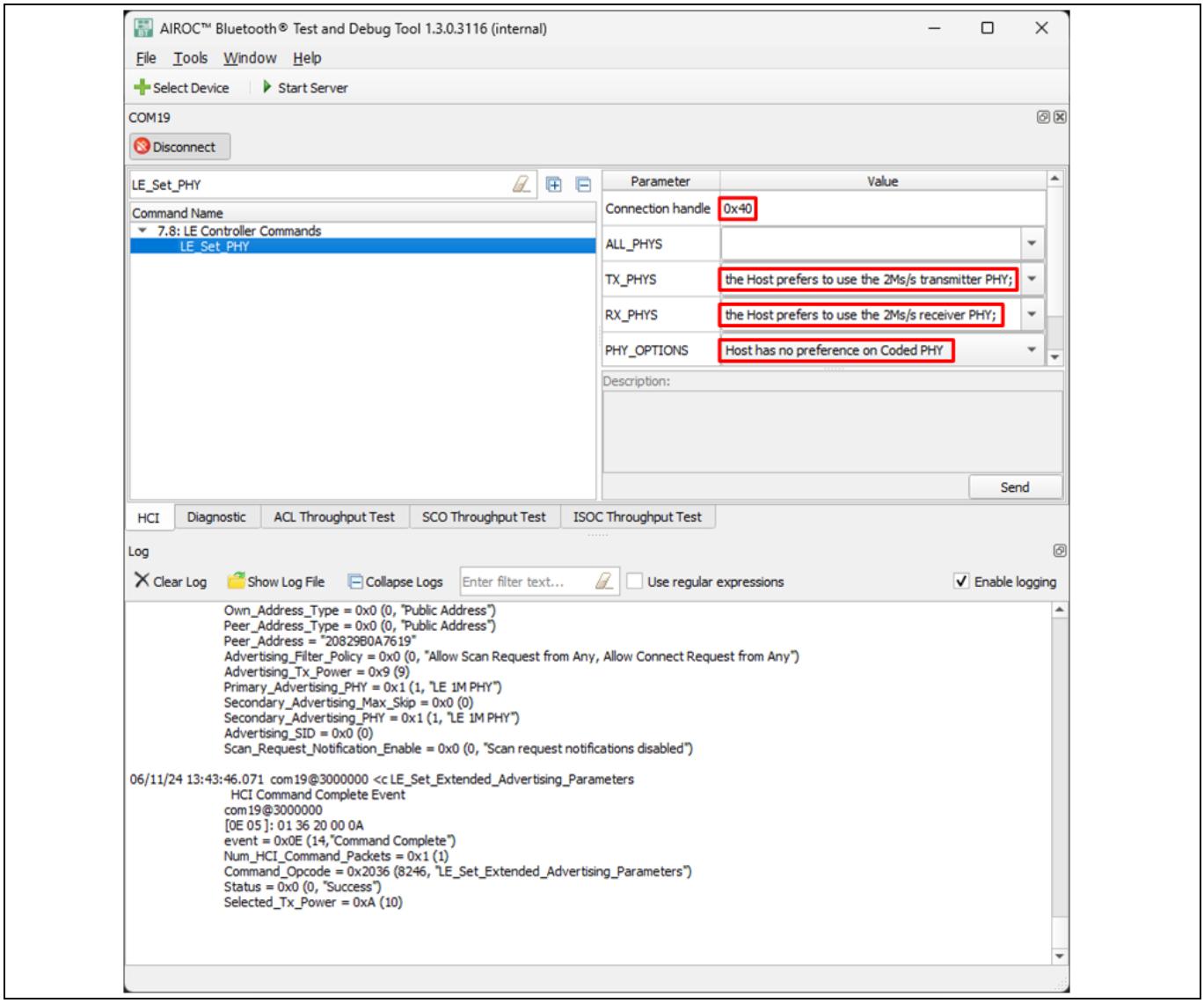

Figure 14 LE 2M LE_Set_PHY command window

To set LE Long Range S = 2, perform the following steps for both the transmitter and receiver:

1. Search **LE_Set_PHY** in the **Search** text box.
2. Select **LE_Set_PHY** command in the **Command Name** tab.
3. On the right window, set the following parameters, and click **Send**.

- **Connection handle:** 0x40
- **TX_PHYS:** the Host prefers to use the Coded transmitter PHY;
- **RX_PHYS:** the Host prefers the use the Coded receiver PHY;
- **PHY_OPTIONS:** Host prefer Coded S_2 [500K]

If successful, you will receive the “Success” status code in the HCI response packet from the DUT

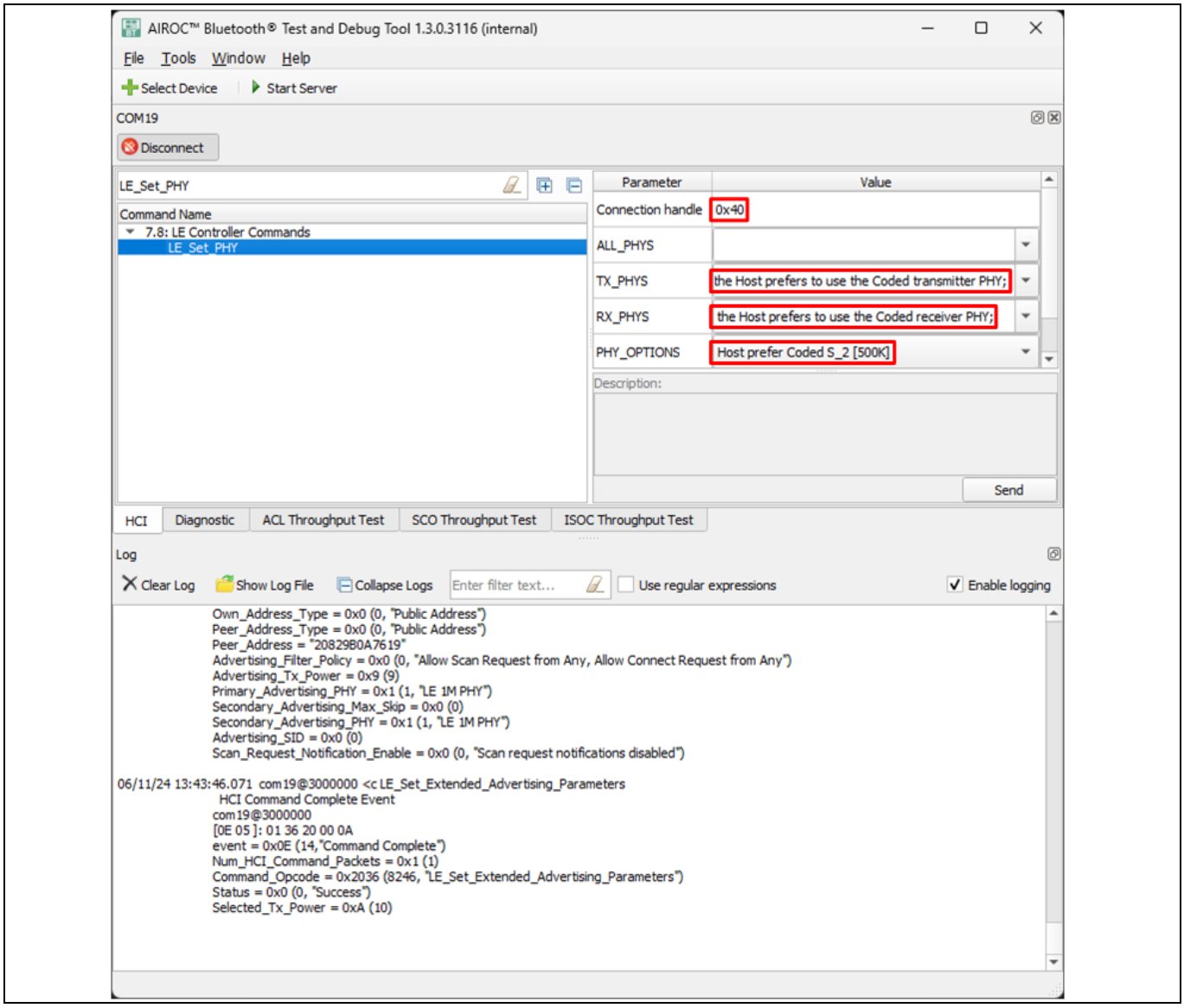

Figure 15 LE Long Range S = 2 LE_Set_PHY command window

To set LE Long Range S = 8, perform the following steps for both the transmitter and receiver:

1. Search **LE_Set_PHY** in the **Search** text box.
2. Select **LE_Set_PHY** command in the **Command Name** tab.
3. On the right window, set the following parameters, and click **Send**.

- **Connection handle:** 0x40
- **TX_PHYS:** the Host prefers to use the Coded transmitter PHY;
- **RX_PHYS:** the Host prefers the use the Coded receiver PHY;
- **PHY_OPTIONS:** Host prefer Coded S_8 [125K]

If successful, you will receive the “Success” status code in the HCI response packet from the DUT.

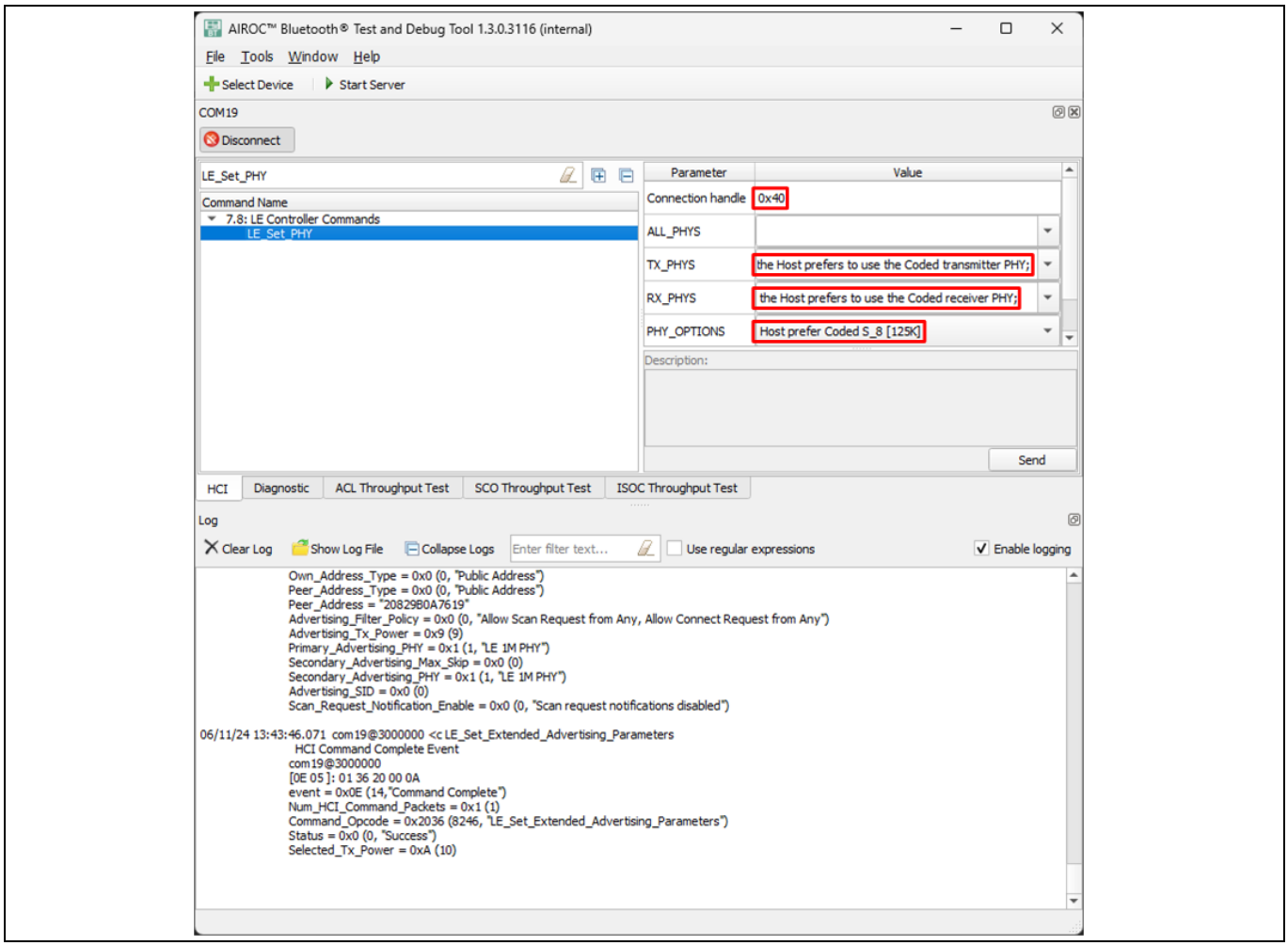

Figure 16 LE Long Range S = 8 LE_Set_PHY command window

2.10 Setting data length

This section is for maximizing data length for better throughput performance.

For both the transmitter and receiver devices

1. Search **LE_Set_Data** in the **Search** text box.
2. Select the **LE_Set_Data_Length** command in the **Command Name** tab.
3. Depending on the PHY set in the previous section, on the right window, select the following parameters to set PHY.

a) For the **LE 1M PHY**, set the following parameters and click **Send**.

- **Connection_Handle:** 0x40
- **TxOctets:** 0xFB
- **TxTime:** 0x848

If successful, you will receive the “Success” status code in the HCI response packet from the DUT.

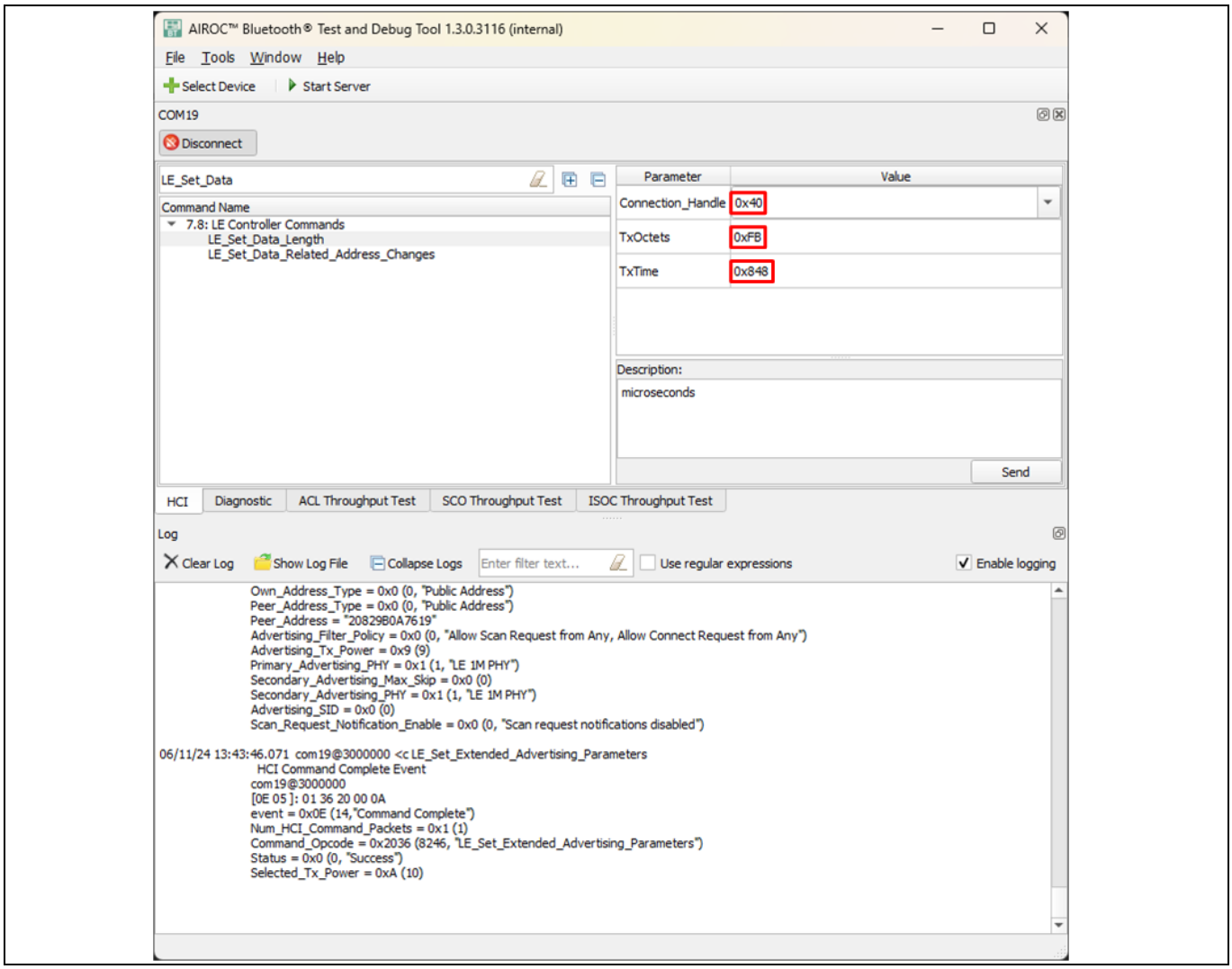

Figure 17 LE 1M LE_Set_Data command window

b) For the **LE 2M PHY**, set the following parameters and click send:

- **Connection_Handle:** 0x40
- **TxOctets:** 0xFB
- **TxTime:** 0x428

If successful, you will receive the “Success” status code in the HCI response packet from the DUT.

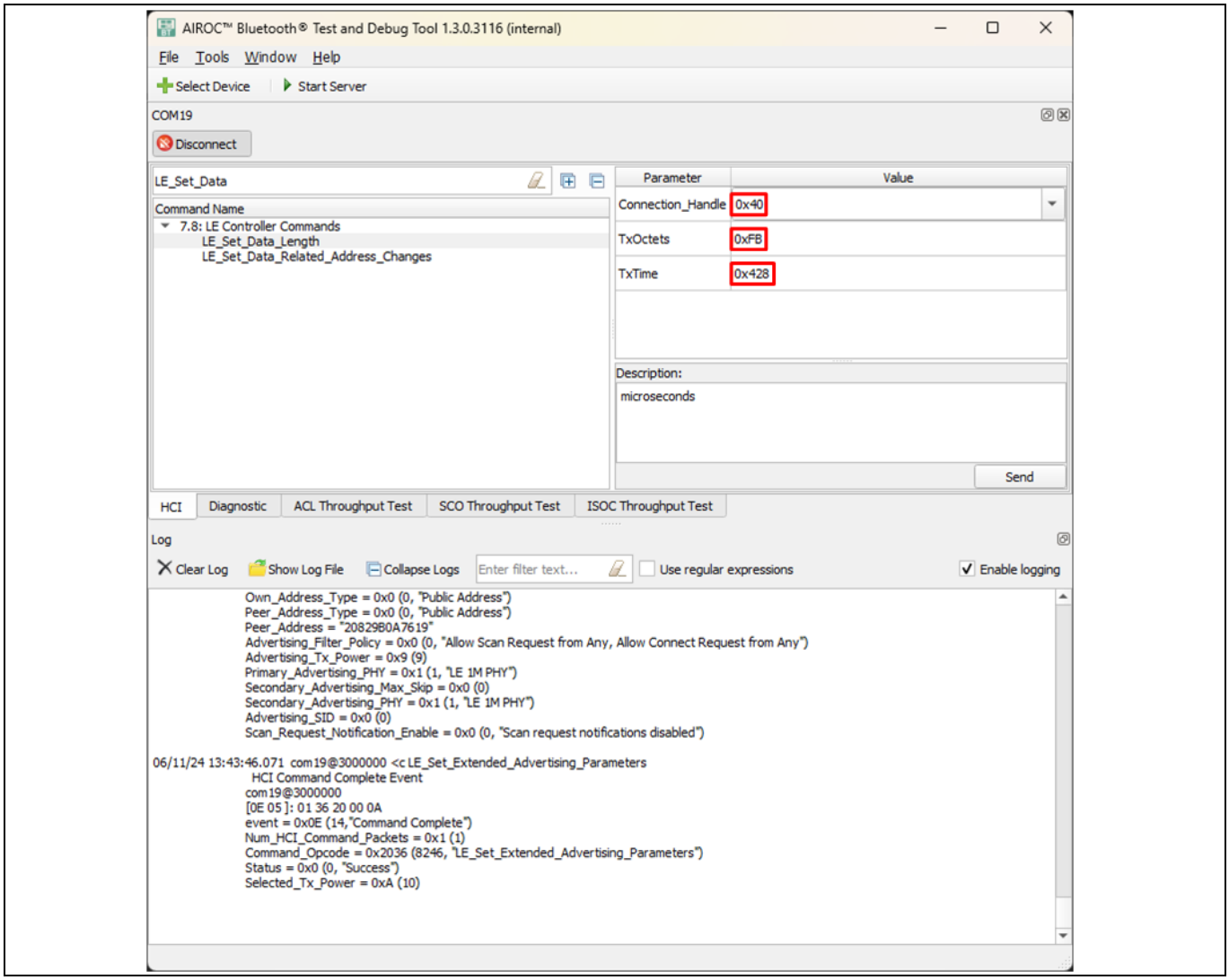

Figure 18 LE 2M LE_Set_Data command window

c) For the **LE Coded S = 2 PHY**, set the following parameters:

- **Connection_Handle:** 0x40
- **TxOctets:** 0xFB
- **TxTime:** 0x11AD

If successful, you will receive the “Success” status code in the HCI response packet from the DUT.

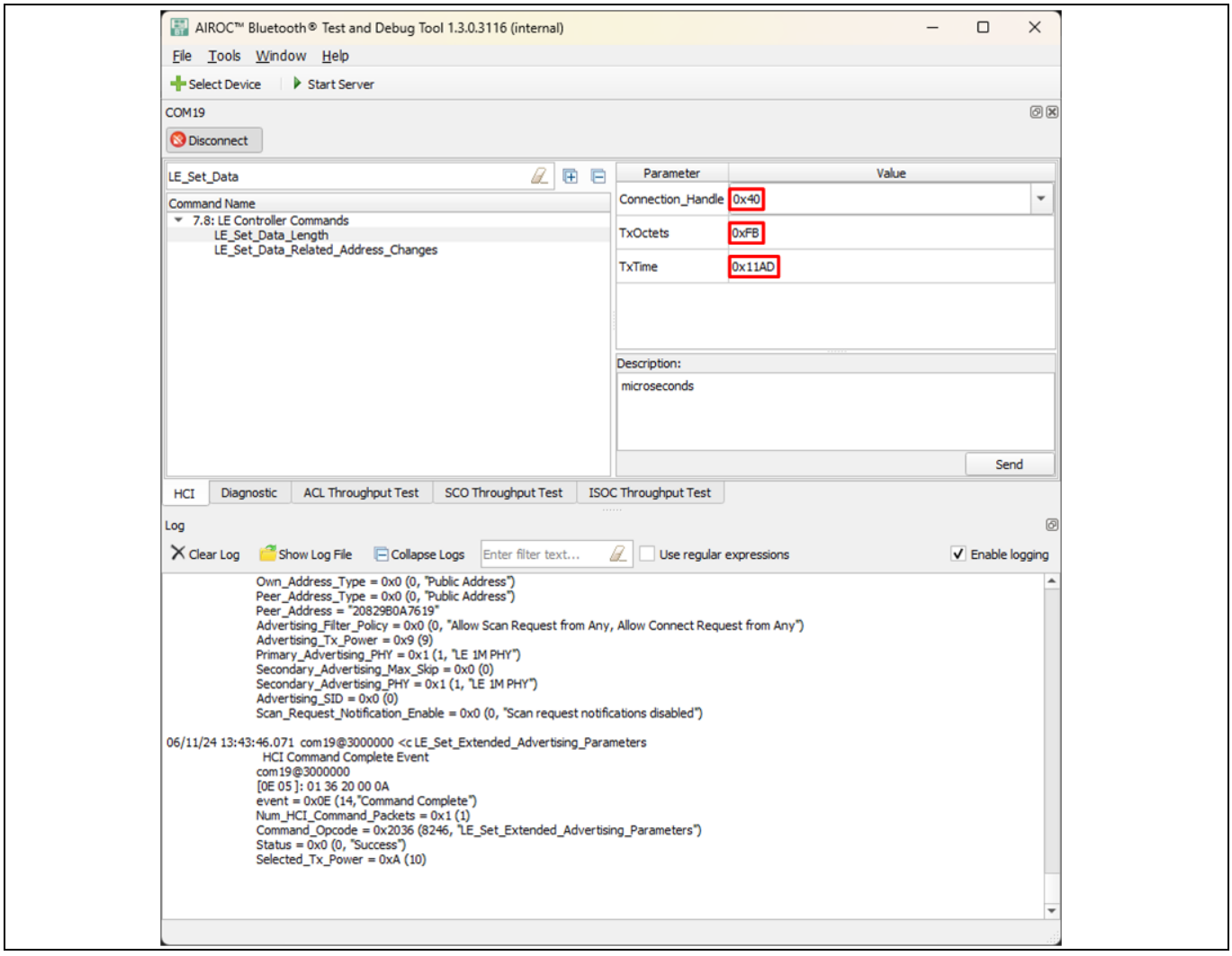

Figure 19 LE Coded S = 2 LE_Set_Data command window

d) For the **LE Coded S = 8 PHY**, set the following parameters:

- **Connection_Handle:** 0x40
- **TxOctets:** 0xFB
- **TxTime:** 0x4290

If successful, you will receive the “Success” status code in the HCI response packet from the DUT.

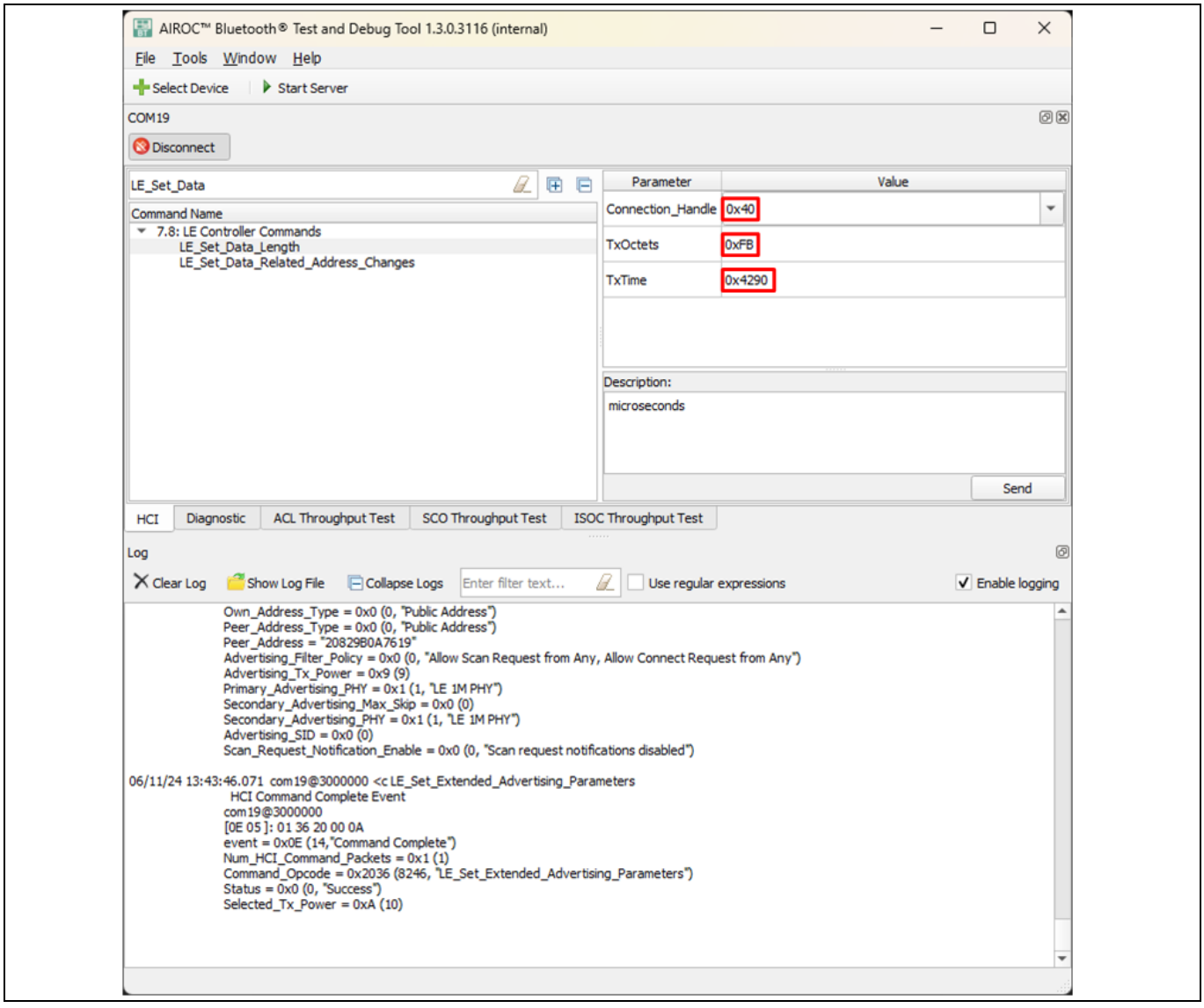

Figure 20 LE Coded S = 8 LE_Set_Data command window

3 Testing throughput

On the transmitter device, perform the following steps:

1. Navigate to the **ACL Throughput Test** tab above the log window.
2. Expand the **Transmit test** tab under **ACL test parameters**.
3. Fill out the tab with the following parameters and click **Start**:

- **Connection handle:** 0x40
- **Connection type:** Auto-detect
- **Operation type:** Run throughput test
- **Mode:** POINT_TO_POINT
- **Select and set Data pattern:** Choose an appropriate data pattern (see note below)
- **Select and set Repeat count:** Choose an appropriate repeat count (see note below)
- **Measurement interval (ms):** 500
- **Select and set Sync with:** Select the COM PORT of your receiver device (sync function is only available if your devices are connected to the same computer)

Note:

1. *If your two devices are not connected to the same computer do not check the **Sync with** box.*
2. *Adjust the **Data pattern** and **Repeat count** parameters until the **Total bytes** value is at your desired size.*
    a. *For a total of 1024 kB, a data pattern of '31' and a repeat count of '1024000' can be used*

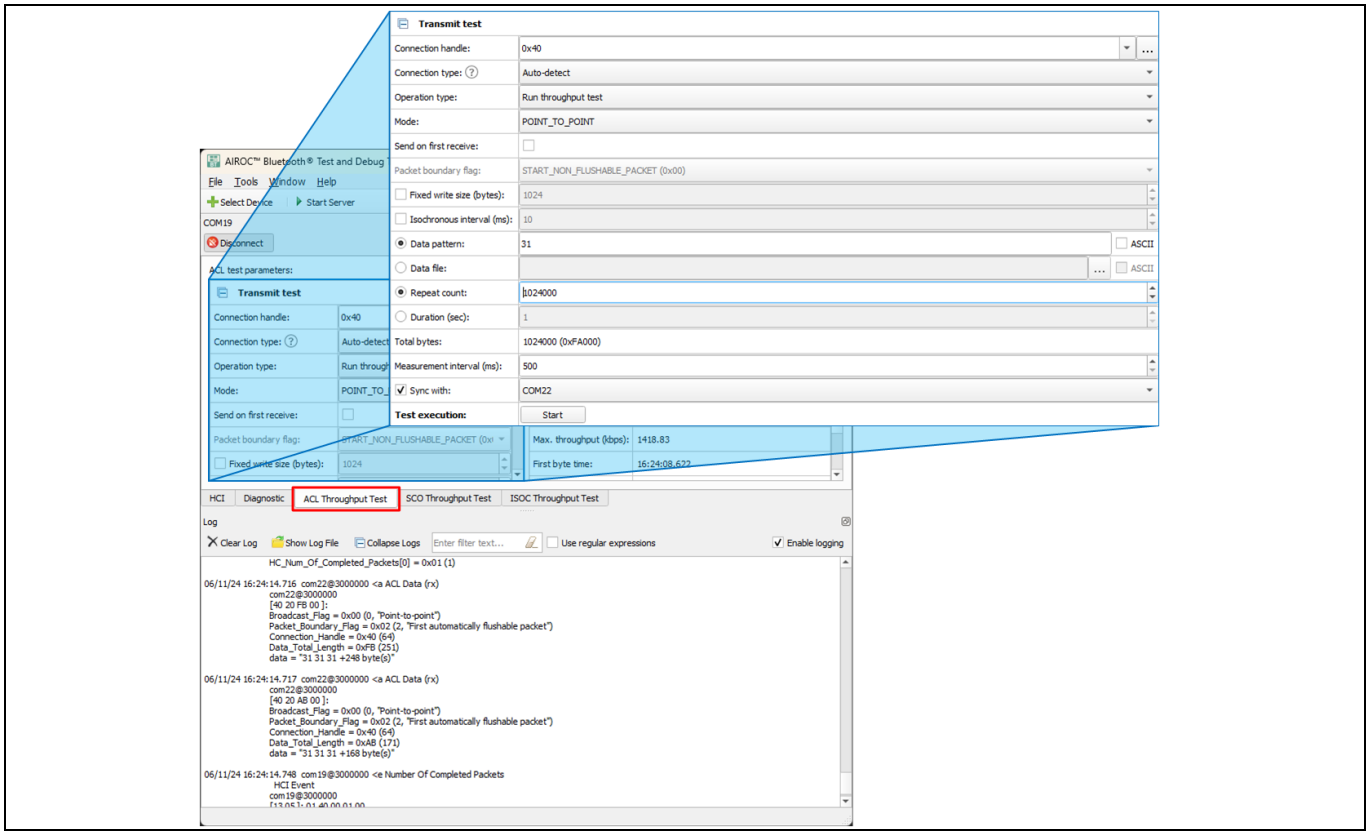

Figure 21 ACL Throughput Test for transmitter

On the receiver device, perform the following steps:

1. Navigate to **ACL Throughput Test** tab above the log window.
2. Expand the **Receive test** tab under **ACL test parameters**.
3. Copy the parameters from your transmitter device.

- **Connection handle:** 0x40
- **Select and set data pattern:** Copy the data pattern from your transmitter
- **Repeat count:** Copy the repeat count from your transmitter
- **Measurement interval (ms):** 500
- **Sync:** Sync will automatically be selected and set if set from the transmitter side

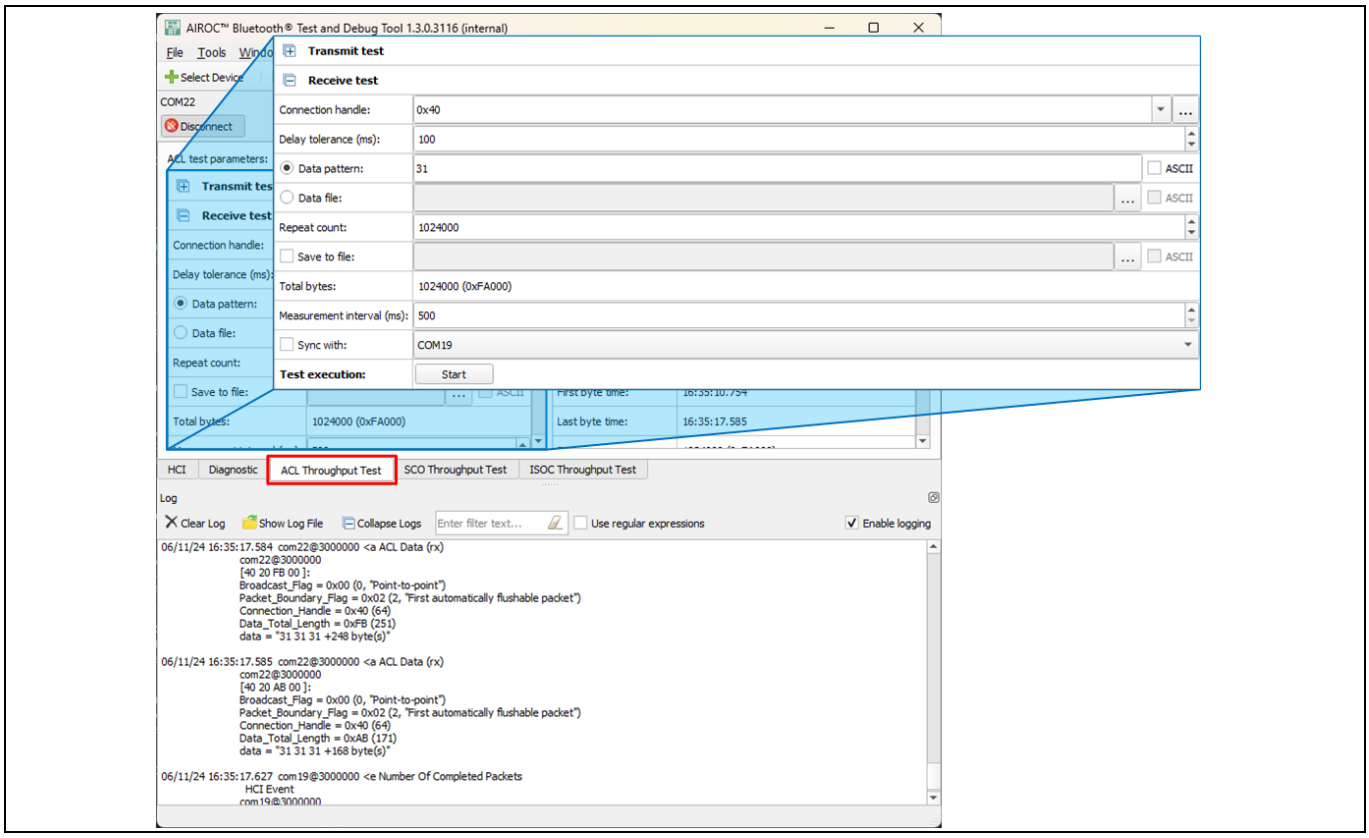

Figure 22 ACL Throughput Test for receiver

4. In the **Receive test** tab, click **Start**.

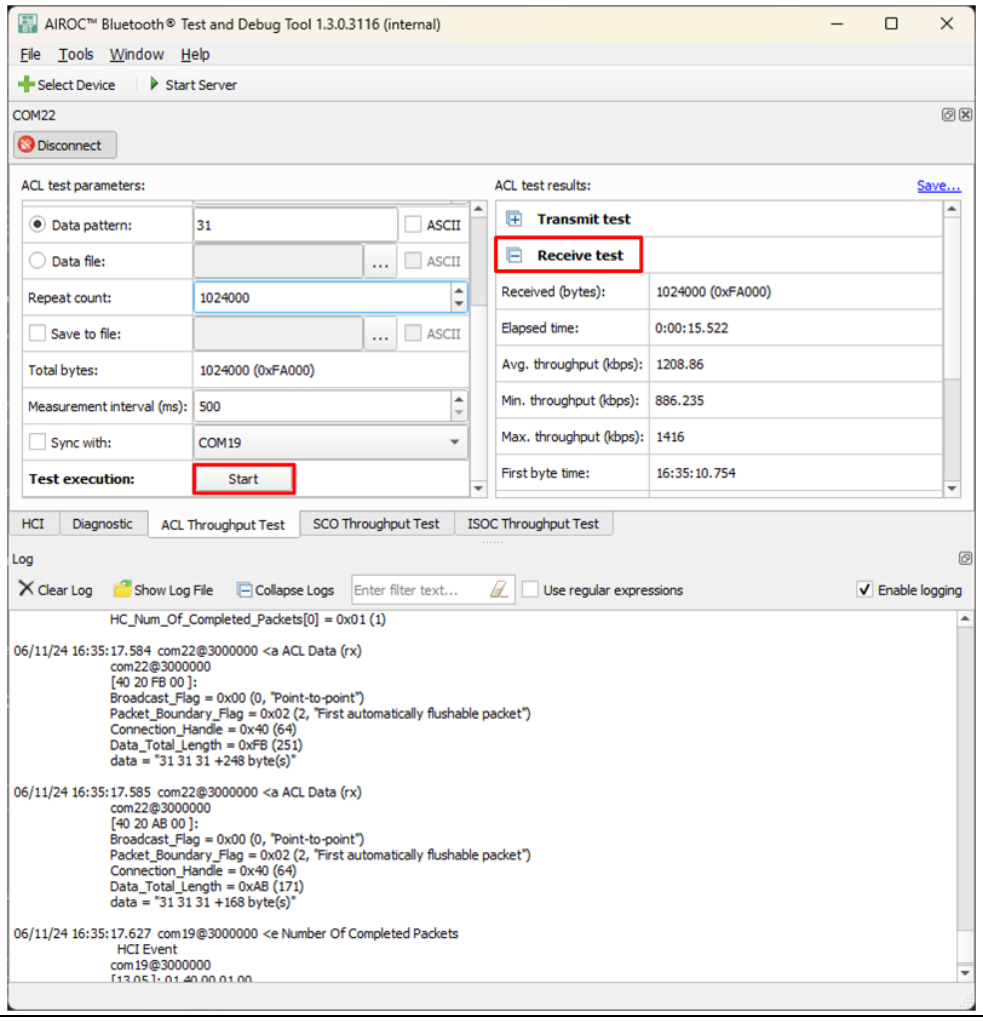

Figure 23 ACL Throughput start receiver test

5. In the **Transmit test** tab, click **Start**.

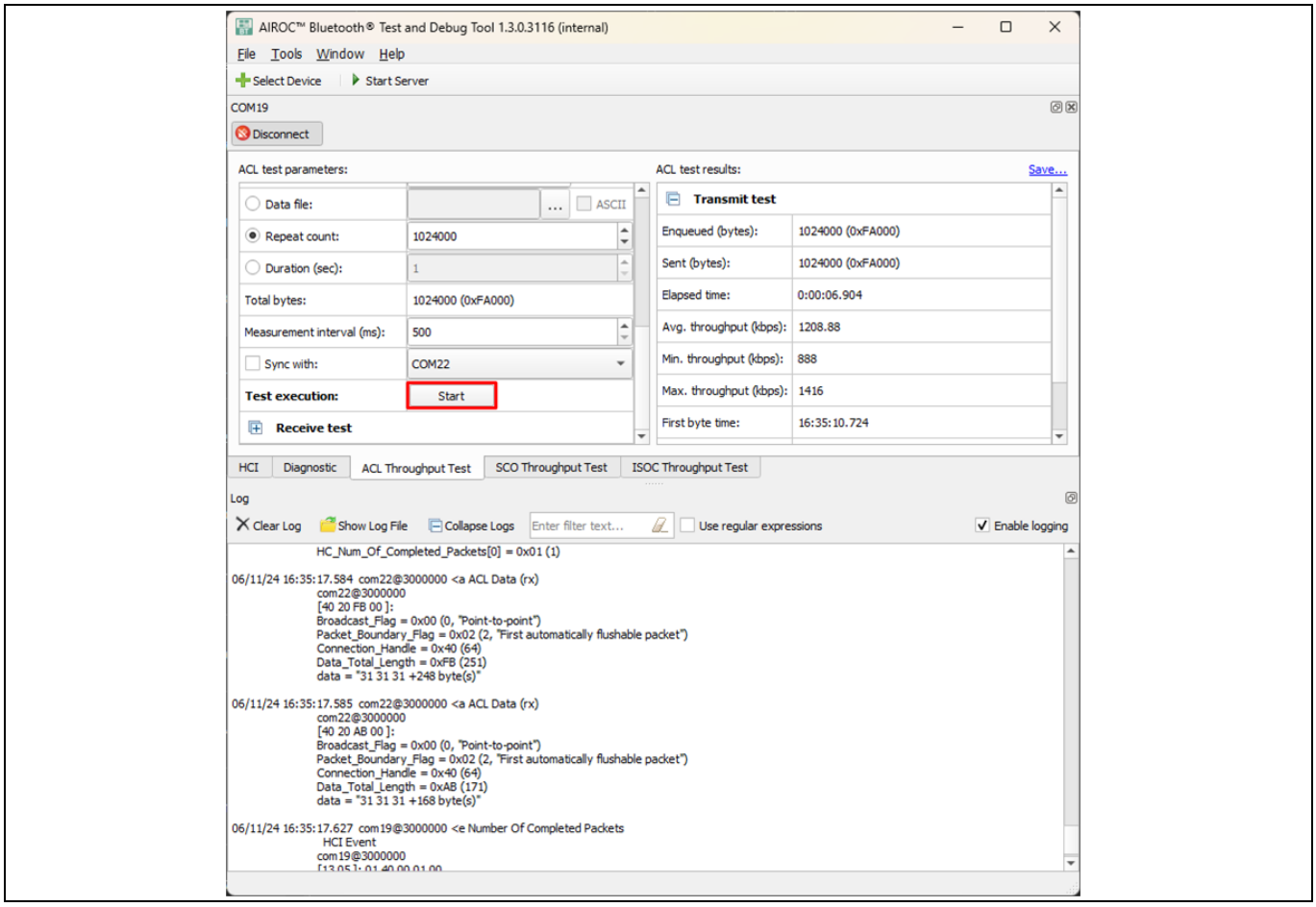

Figure 24 ACL Throughput start transmitter test

The throughput measurements should begin to appear on the **Receive test tab** under **ACL test results**.

6. Once the test is complete, click **Save...** on the top right corner of the **ACL test results** to save your results.

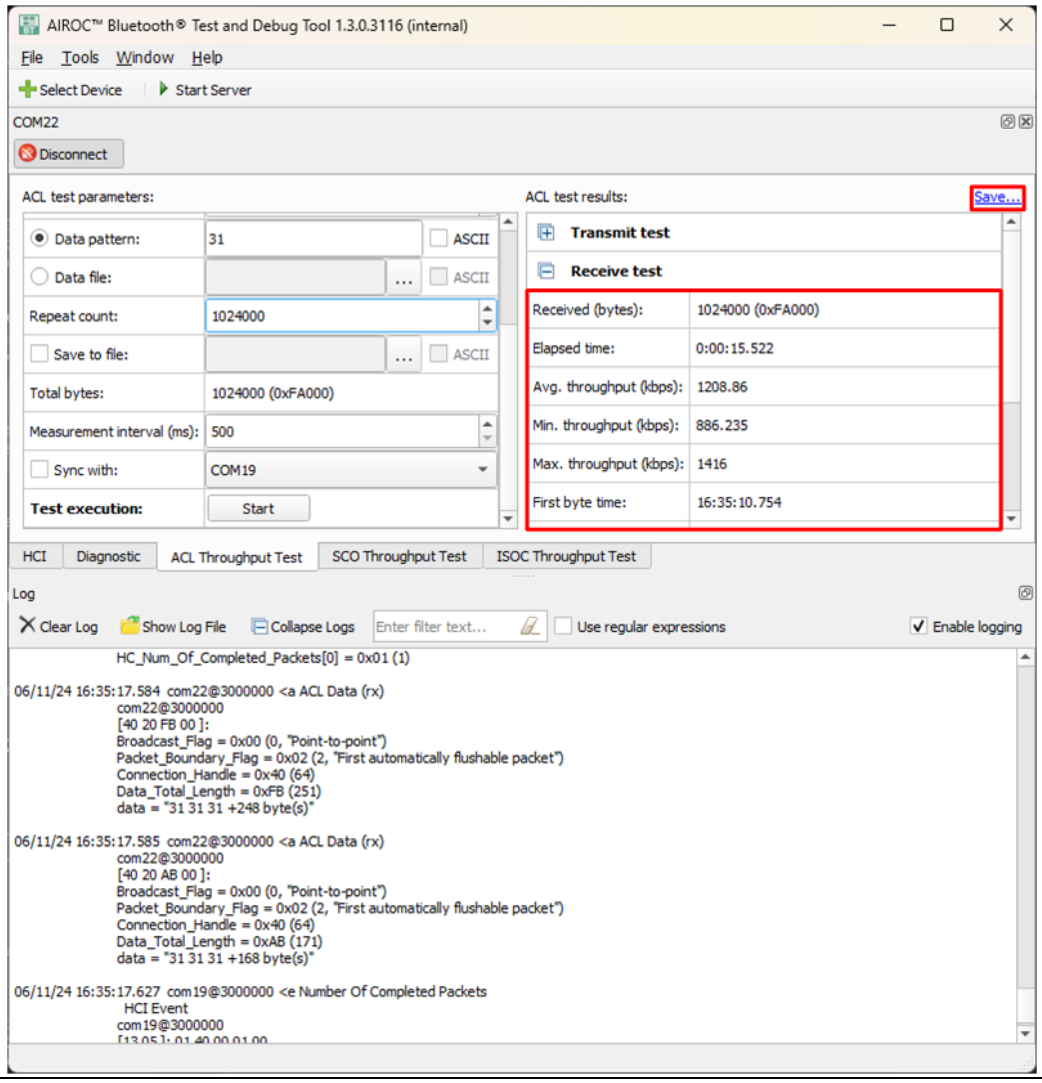

Figure 25 Throughput test results

Revision history

Document revision	Date	Description of changes
**	2024-07-17	Initial release

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Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.