Pulse Oximeter Profile (PLXP)

Bluetooth® Test Suite

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Contents

1   Scope

This Bluetooth document contains the Test Suite Structure (TSS) and test cases to test the implementation of the Bluetooth Pulse Oximeter Profile Specification with the objective to provide a high probability of air interface interoperability between the tested implementation and other manufacturers' Bluetooth devices.

2   References, definitions, and abbreviations

2.1   References

This document incorporates provisions from other publications by dated or undated reference. These references are cited at the appropriate places in the text, and the publications are listed hereinafter. Additional definitions and abbreviations can be found in [1] and [2].

[1]   Bluetooth Core Specification, Version 4.0 or later

[2]   Test Strategy and Terminology Overview

[3]   Pulse Oximeter Profile Specification, Version 1.0

[4]   Pulse Oximeter Service Specification, Version 1.0

[5]   ICS Proforma for Pulse Oximeter Profile

[6]   GATT Test Suite, GATT.TS

[7]   Current Time Service Specification, Version 1.0 or later

[8]   Device Information Service Specification, Version 1.1

[9]   Battery Service Specification, Version 1.0

[10]   GAP Test Suite, GAP.TS

[11]   Bond Management Service Specification, Version 1.0

[12]   Pulse Oximeter Service Test Suite, PLXS.TS

[13]   Characteristic and Descriptor descriptions are accessible via the Bluetooth SIG Assigned Numbers

[14]   PLX Profile Implementation eXtra Information for Test, IXIT

[15]   Pulse Oximeter Profile Specification, Version 1.0.1

[16]   Appropriate Language Mapping Tables document

2.2   Definitions

In this Bluetooth document, the definitions from [1] and [2] apply.

2.3   Acronyms and abbreviations

In this Bluetooth document, the definitions, acronyms, and abbreviations from [1] and [2] apply.

Certain terms that were identified as inappropriate have been replaced. For a list of the original terms and their replacement terms, see the Appropriate Language Mapping Tables document [16].

3   Test Suite Structure (TSS)

3.1   Overview

The Pulse Oximeter Profile requires the presence of GAP, SM (for LE), SDP (for BR/EDR), ATT, and GATT. This is illustrated in Figure 3.1.
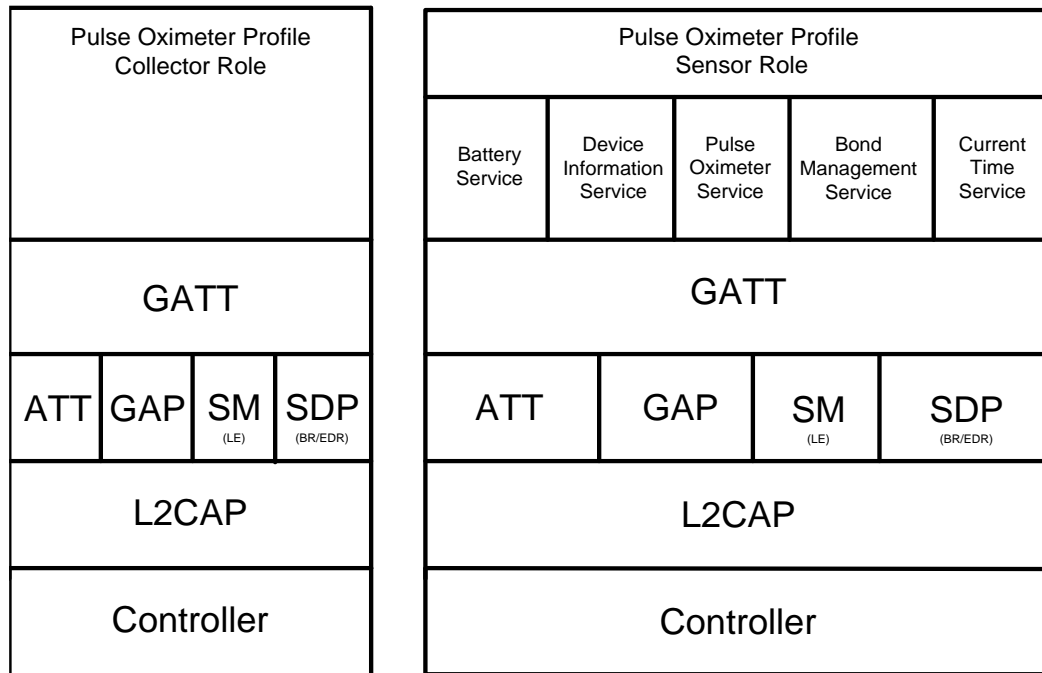
Figure 3.1: Pulse Oximeter Profile test model

Supporting the Device Information Service and the Pulse Oximeter Service is mandatory. Supporting the Bond Management Service, Battery Service, and/or Current Time Service is optional.

3.2   Test Strategy

The test objectives are to verify functionality of the Pulse Oximeter Profile within a Bluetooth Host and enable interoperability between Bluetooth Hosts on different devices. The testing approach covers mandatory and optional requirements in the specification and matches these to the support of the IUT as described in the ICS. Any defined test herein is applicable to the IUT if the ICS logical expression defined in the Test Case Mapping Table (TCMT) evaluates to true.

The test equipment provides an implementation of the Radio Controller and the parts of the Host needed to perform the test cases defined in this Test Suite. A Lower Tester acts as the IUT's peer device and interacts with the IUT over-the-air interface. The configuration including the IUT needs to implement similar capabilities to communicate with the test equipment. For some test cases, it is necessary to stimulate the IUT from an Upper Tester. In practice, this could be implemented as a special test interface, a Man Machine Interface (MMI), or another interface supported by the IUT.

This Test Suite contains Valid Behavior (BV) tests complemented with Invalid Behavior (BI) tests where required. The test coverage mirrored in the Test Suite Structure is the result of a process that started with catalogued specification requirements that were logically grouped and assessed for testability enabling coverage in defined test purposes.

3.3 Test groups

The following test groups have been defined:

- Pulse Oximeter Sensor Role Requirements

- Generic GATT Integrated Tests

- Configure indication and notification

- PLX Spot-check Measurements

- PLX Continuous Measurements

- Common Behavior for PLX Features and Bond Management Feature characteristics

- Record Access Control Point Procedures

- Bond Management Service Procedures

- Current Time Service Features

- Battery Service Features

- Connection Establishment

4   Test cases (TC)

4.1   Introduction

4.1.1   Test case identification conventions

Test cases are assigned unique identifiers per the conventions in [2]. The convention used here is:
<spec abbreviation>/<IUT role>/<class>/**<feat>**/<func>/<subfunc>**/<cap>/<xx>-<nn>-<y>**.

Additionally, testing of this specification includes tests from the GATT Test Suite [6] referred to as Generic GATT Integrated Tests (GGIT); when used, the test cases in GGIT are referred to through a TCID string using the following convention:
<spec abbreviation>/<IUT role>/<GGIT test group>/< GGIT class >/<xx>-<nn>-<y>.

Identifier Abbreviation	Spec Identifier <spec abbreviation>
PLXP	Pulse Oximeter Profile
Identifier Abbreviation	**Role Identifier <IUT role>**
COL	Collector Role
SEN	Sensor Role
Identifier Abbreviation	**Reference Identifier <GGIT test group>**
CGGIT	Client Generic GATT Integrated Tests
SGGIT	Server GGIT test procedures
Identifier Abbreviation	**Reference Identifier <GGIT class>**
CHA	Characteristic
ISFC	Indication Supported Features Characteristic
SDPNF	SDP Record Not Found
SER	Service
Identifier Abbreviation	**Feature and Behaviors Identifier <feat>**
BAS	Battery Service
BMS	Bond Management Service
CECC	Connection Establishment
CON	Configure characteristics for Indication or Notification
CTS	Current Time Service Features
PLXC	Pulse Oximeter Continuous Measurement
PLXF	Pulse Oximeter Features
PLXS	(Sensor) Requirements
PLXSC	Pulse Oximeter Spot-check Measurement
PLXSD	Discovery of Services and Characteristics
RAA	Record Access Control Point – Abort Procedures
RAD	Record Access Control Point – Delete Procedures
RAR	Record Access Control Point – Report Procedures
RAT	Record Access Control Point – Procedure Timeout

Table 4.1: PLXP TC feature naming conventions

4.1.2   Conformance

When conformance is claimed for a particular specification, all capabilities are to be supported in the specified manner. The mandated tests from this Test Suite depend on the capabilities to which conformance is claimed.

The Bluetooth Qualification Program may employ tests to verify implementation robustness. The level of implementation robustness that is verified varies from one specification to another and may be revised for cause based on interoperability issues found in the market.

Such tests may verify:

- That claimed capabilities may be used in any order and any number of repetitions not excluded by the specification

- That capabilities enabled by the implementations are sustained over durations expected by the use case

- That the implementation gracefully handles any quantity of data expected by the use case

- That in cases where more than one valid interpretation of the specification exists, the implementation complies with at least one interpretation and gracefully handles other interpretations

- That the implementation is immune to attempted security exploits

A single execution of each of the required tests is required to constitute a Pass verdict. However, it is noted that to provide a foundation for interoperability, it is necessary that a qualified implementation consistently and repeatedly pass any of the applicable tests.

In any case, where a member finds an issue with the test plan generated by the Bluetooth SIG qualification tool, with the test case as described in the Test Suite, or with the test system utilized, the member is required to notify the responsible party via an erratum request such that the issue may be addressed.

4.1.3   Pass/Fail verdict conventions

Each test case has an Expected Outcome section. The IUT is granted the Pass verdict when all the detailed pass criteria conditions within the Expected Outcome section are met.

The convention in this Test Suite is that, unless there is a specific set of fail conditions outlined in the test case, the IUT fails the test case as soon as one of the pass criteria conditions cannot be met. If this occurs, then the outcome of the test is a Fail verdict.

4.2   Setup preambles

The procedures defined in this section are used to achieve specific conditions on the IUT and the test equipment within the tests defined in this document. The preambles here are commonly used to establish initial conditions.

4.2.1   ATT Bearer on LE transport

- Preamble Procedure

  1. Establish an LE transport connection between the IUT and the Lower Tester.
  2. Establish an L2CAP channel 0x0004 between the IUT and the Lower Tester over that LE transport.

4.2.2　ATT Bearer on BR/EDR transport

• Preamble Procedure

1. Establish a BR/EDR transport connection between the IUT and the Lower Tester.
2. Establish an L2CAP channels (PSM 0x001F) between the IUT and the Lower Tester over that BR/EDR transport.

4.2.3　Collector: Configure Sensor for use with Record Access Control Point

• Preamble Purpose

This preamble procedure enables the Collector to configure the Sensor for use with Record Access Control Point.

• Preamble Procedure

1. Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1 if using LE Transport or Section 4.2.2 if using a BR/EDR Transport.
2. The handles of the PLX Spot-check Measurement characteristic, PLX Continuous Measurement characteristic, and RACP characteristic have been previously discovered by the Lower Tester during the test procedures in Section 4.4 or are known to the Lower Tester by other means.
3. The handles of the Client Characteristic Configuration descriptor of the PLX Spot-check Measurement characteristic, PLX Continuous Measurement characteristic, and RACP characteristic have been previously discovered by the Lower Tester during the test procedure in Section 4.4 or are known to the Lower Tester by other means.
4. If the Lower Tester and IUT were not previously bonded, perform a bonding procedure. If previously bonded, enable encryption if not already enabled.
5. The PLX Spot-check Measurement characteristic is configured for indications.
6. The PLX Continuous Measurement characteristic is configured for notifications.
7. The RACP characteristic is configured for indications.

4.2.4　LE Collector: Scan to detect Sensor advertisements

• Preamble Purpose

This procedure specifies how a Collector IUT scans and detects Sensor advertisements.

• Reference

Section 6.1 in [3], GAP 9.3.3, 9.3.4 in [1]

• Initial Condition

- The Collector has been configured to accept commands from the Upper Tester to request and receive pulse oximetry measurements.

• Preamble Procedure

1. Execute one of the following test procedures:

   Alt 1:　GAP/CONN/ACEP/BV-01-C [10]
   or
   Alt 2:　GAP/CONN/GCEP/BV-02-C [10]

2. Connection is established.
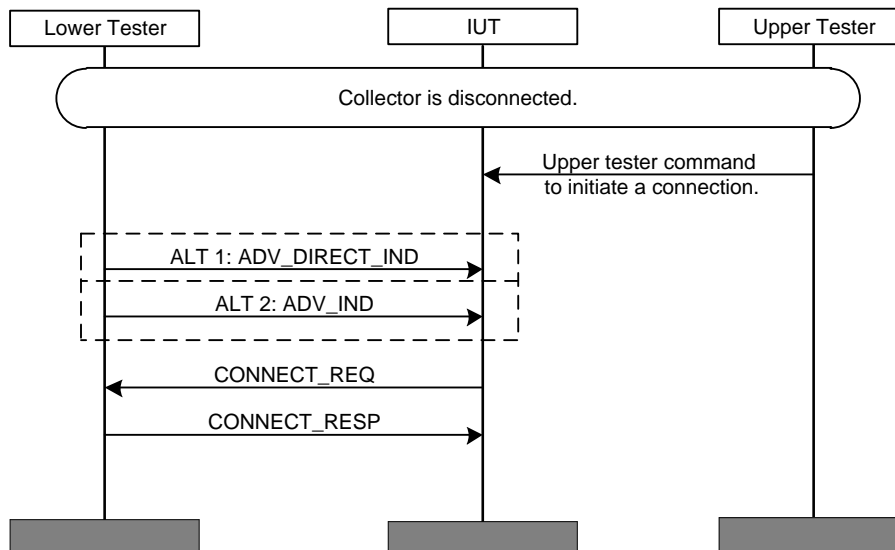
Figure 4.1: Scan to detect Sensor advertisements

4.2.5　BR/EDR Collector

4.2.5.1　Connection Establishment for Unbonded Device

- Preamble Purpose

  This BR/EDR preamble procedure specifies how the Collector IUT scans the Sensor for the case when the Sensor and Collector have not bonded.

- Reference

  Section 6.3.1 in [3], GAP 4.1, 4.2 in [1]

- Initial Condition

  - A preamble procedure defined in Section 4.2.3 is used as a prerequisite to this preamble.

- Preamble Procedure

  1. Put the Sensor in General Discoverable mode.
  2. The Upper Tester commands the Collector IUT to initiate a connection and the IUT starts scanning.
  3. The Sensor (Lower Tester) exposes the SDP record for the Pulse Oximeter Service.
  4. The Collector IUT validates the SDP record and establishes a connection to the Sensor.
  5. The Collector uses the GAP General Discovery procedures to discover a Sensor and to establish a connection to a Sensor.

4.2.5.2　Connection Establishment for Bonded Device

In the case of BR/EDR, either a Sensor or Collector could initiate a connection when they are bonded. The device which initiates a connection becomes a Central is referred here as "Central to be" and the device which accepts the connection becomes a Peripheral and is referred here as "Peripheral to be".

The BR/EDR preamble procedure specifies how a "Central to be" connects to a "Peripheral to be".

- Reference

  Section 6.3.2 in [3], GAP 4.1, 4.2 in [1]

- Initial Condition

    - A preamble procedure defined in Section 4.2.3 is used as a prerequisite to this preamble.

- Preamble Procedure

    1. Put the "Peripheral to be" in connectable mode to accept a connection from "Central to be".
    2. The connection is initiated by "Central to be".
    3. The "Peripheral to be" exposes the SDP record for the Pulse Oximeter Service.
    4. The "Central to be" validates the SDP record and establishes a connection to the "Peripheral to be".
    5. The "Central to be" uses the GAP Link Establishment procedures to connect to any bonded device.

4.3 Pulse Oximeter Sensor Role Requirements – Additional Requirements for LE

These procedures defined in this test group verify implementation of the additional Sensor requirements and recommendations defined in the Pulse Oximeter Profile Specification [3] when using this profile over Low Energy transport.

PLXP/SEN/PLXS/BV-01-C [Pulse Oximeter Service UUID in AD over LE]

- Test Purpose

    Verify that the Pulse Oximeter Service UUID is included in AD (Advertising Data) from the Pulse Oximeter Sensor IUT when using LE Transport.

- Reference

    [3] 4.1.2.1

- Initial Condition

    - The IUT is induced to enter a GAP discoverable mode and generate Advertising Packets (see Section 4.2.4).

- Test Procedure

    The Lower Tester listens for Advertising Packets from the IUT.

- Expected Outcome

    Pass verdict

    The Advertising Packets contain the defined Service UUID for «Pulse Oximeter Service».

PLXP/SEN/PLXS/BV-02-C [Local Name included in AD or Scan Response over LE]

- Test Purpose

    Verify that the Local Name is included in AD (Advertising Data) or Scan Response data from the Sensor IUT when using LE Transport.

- Reference

    [3] 4.1.2.2

- Initial Condition

    - The IUT is induced to enter a GAP connectable mode and generate Advertising Packets.

- Test Procedure

The Lower Tester listens for Advertising Packets from the IUT. When the Lower Tester receives an Advertising Packet from IUT, it sends a Scan Request to the IUT. Then the Lower Tester listens for a Scan Response from the IUT.

- Expected Outcome

Pass verdict

The IUT sends an Advertising packet and a Scan Response packet.

The IUT includes the Local Name in either the Advertising packet or Scan Response packet, but not both.

PLXP/SEN/PLXS/BV-03-C [Appearance included in AD or Scan Response over LE]

- Test Purpose

Verify that the Appearance is included in AD (Advertising Data) or Scan Response data from the Sensor IUT when using LE Transport.

- Reference

[3] 4.1.2.3

- Initial Condition

  - The IUT is induced to enter a GAP connectable mode and generate Advertising Packets.

- Test Procedure

The Lower Tester listens for Advertising Packets from the IUT. When the Lower Tester receives an Advertising Packet from IUT, it sends a Scan Request to the IUT. Then the Lower Tester listens for a Scan Response from the IUT.

- Expected Outcome

Pass verdict

The IUT sends an Advertising packet and a Scan Response packet.

The IUT includes the Appearance in either the Advertising packet or Scan Response packet, but not both.

4.4 Generic GATT Integrated Tests

Execute the Generic GATT Integrated Tests defined in Section 6.4, Client test procedures (CGGIT), in [6] using Table 4.2 below as input:

TCID	Service / Characteristic / Descriptor	Reference	Properties	Value Length (Octets)	Type
PLXP/COL/CGGIT/SER/BV-01-C [Service GGIT – Pulse Oximeter]	Pulse Oximeter Service	[3] 5.2.1	-	-	Primary Service
PLXP/COL/CGGIT/CHA/BV-01-C [Characteristic GGIT – PLX Spot-check Measurement]	PLX Spot-check Measurement characteristic	[3] 5.3.1.1	0x20 (Indicate)	Skip	-
PLXP/COL/CGGIT/CHA/BV-02-C [Characteristic GGIT – PLX Continuous Measurement]	PLX Continuous Measurement characteristic	[3] 5.3.1.2	0x10 (Notify)	Skip	-
PLXP/COL/CGGIT/CHA/BV-03-C [Characteristic GGIT – PLX Features]	PLX Features characteristic	[15] 5.3.1.3	0x22 (Read, Indicate)	2, 4, 5, or 7	-
PLXP/COL/CGGIT/CHA/BV-04-C [Characteristic GGIT – Record Access Control Point]	Record Access Control Point characteristic	[3] 5.3.1.4	0x28 (Write, Indicate)	Skip	-
PLXP/COL/CGGIT/SER/BV-02-C [Service GGIT – Device Information]	Device Information Service	[3] 5.2.2	-	-	Primary Service
PLXP/COL/CGGIT/SER/BV-03-C [Service GGIT – Current Time]	Current Time Service	[3] 5.2.4	-	-	Primary Service
PLXP/COL/CGGIT/CHA/BV-05-C [Characteristic GGIT – Current Time]	Current Time characteristic	[3] 5.3.4	0x1A (Read, Notify, Write)	Skip	-
PLXP/COL/CGGIT/SER/BV-04-C [Service GGIT – Bond Management]	Bond Management Service	[3] 5.2.3	-	-	Primary Service
PLXP/COL/CGGIT/CHA/BV-06-C [Characteristic GGIT – Bond Management Control Point]	Bond Management Control Point characteristic	[3] 5.3.2.1	0x88 (Write, Reliable Writes)	Skip	-
PLXP/COL/CGGIT/CHA/BV-07-C [Characteristic GGIT – Bond Management Feature]	Bond Management Feature characteristic	[15] 5.3.2.2	0x22 (Read, Indicate)	1-3	-

TCID	Service / Characteristic / Descriptor	Reference	Properties	Value Length (Octets)	Type
PLXP/COL/CGGIT/SER/BV-05-C [Service GGIT – Battery]	Battery Service	[3] 5.2.5	-	-	Not defined
PLXP/COL/CGGIT/CHA/BV-08-C [Characteristic GGIT – Battery Level]	Battery Level characteristic	[3] 5.3.5	0x12 (Read, Notify)	Skip	-
PLXP/SEN/SGGIT/SDPNF/BV-01-C [Not discoverable over BR/EDR – Pulse Oximeter Service]	Pulse Oximeter Service	[3] 5.2	-	-	-
PLXP/SEN/SGGIT/SDPNF/BV-02-C [Not discoverable over BR/EDR – Device Information Service]	Device Information Service	[3] 5.2	-	-	-
PLXP/SEN/SGGIT/SDPNF/BV-03-C [Not discoverable over BR/EDR – Current Time Service]	Current Time Service	[3] 5.2	-	-	-
PLXP/SEN/SGGIT/SDPNF/BV-04-C [Not discoverable over BR/EDR – Bond Management Service]	Bond Management Service	[3] 5.2	-	-	-
PLXP/SEN/SGGIT/SDPNF/BV-05-C [Not discoverable over BR/EDR – Battery Service]	Battery Service	[3] 5.2	-	-	-

Table 4.2: Input for the GGIT Client test procedure

4.4.1   Generic GATT Indication Supported Features characteristic

Execute the Generic GATT Indication Supported Features Characteristic tests defined in Section 6.4, Client test procedures (CGGIT), in [6] using Table 4.3 below as input:

TCID	Characteristic	Reference	TC Configuration
PLXP/COL/CGGIT/ISFC/BV-01-C [Characteristic GGIT – PLX Features indication]	PLX Features	[15] 5.6	N/A
PLXP/COL/CGGIT/ISFC/BV-02-C [Characteristic GGIT – Bond Management Feature indication]	Bond Management Feature	[15] 5.8.5	N/A

Table 4.3: GGIT Indication Supported Features Characteristic tests

4.4.2 Discovery and reading of supported Device Information Service characteristics

PLXP/COL/PLXSD/BV-19-C [Discover Device Information Service Characteristics]

- Test Purpose

  Verify that a Collector IUT can discover all characteristics of a Device Information Service supported by the IUT.

- Reference

  [3] 5.3.3

- Initial Condition

  - Via IXIT [14] the IUT manufacturer specifies all characteristics of the Device Information Service supported by the IUT.

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  - The Lower Tester includes one instantiation of the Device Information Service including all defined characteristics.

  - The IUT has executed PLXP/COL/CGGIT/SER/BV-02-C [Service GGIT – Device Information] procedure and has saved the handle range for the instantiation of the Device Information Service contained in the Lower Tester. The Device Information Service contains one or more characteristics.

- Test Procedure

  1. The Upper Tester issues a command to the IUT to discover all characteristics of the Device Information Service supported by the IUT.
  2. The IUT executes either alternative 2A or 2B.

     Alternative 2A (Discover All Characteristics of a Service sub-procedure):
     2A: Discover All Characteristics of a Service using the specified handle range, with the Lower Tester instantiating the database specified in the Initial Condition.
     Alternative 1B (Discover Characteristics by UUID sub-procedure):
     2B: Discover Characteristics by UUID using each of the UUIDs for the characteristics of the Device Information Service supported by the IUT, with the Lower Tester instantiating the database specified in the Initial Condition.

- Expected Outcome

  Pass verdict

  For each characteristic specified in the IXIT [14], the IUT reports an attribute handle/value pair to the Upper Tester.

PLXP/COL/PLXSD/BV-20-C [Read Device Information Service Characteristics]

- Test Purpose

  Verify that a Collector IUT can read all characteristics of a Device Information Service supported by the IUT.

- Reference

  [3] 5.3.3

- Initial Condition

  - Via IXIT [14] the IUT manufacturer specifies all characteristics of the Device Information Service supported by the IUT.

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  - The Lower Tester includes one instantiation of the Device Information Service [8] including all defined characteristics.

  - The IUT has previously executed the PLXP/COL/PLXSD/BV-19-C [Discover Device Information Service Characteristics] procedure and it has the handle/value pairs for all characteristics of the Device Information Service supported by the IUT.

- Test Procedure

  1. The Upper Tester issues a command to the IUT to read all characteristics of the Device Information Service supported by the IUT.
  2. For each characteristic of the Device Information Service supported by the IUT, the IUT sends an *ATT_Read_Request* to the Lower Tester containing the handle specified by the Upper.
  3. The IUT receives an *ATT_Read_Response* and reports the value to the Upper Tester.

- Expected Outcome

  <u>Pass verdict</u>

  For each characteristic specified in the IXIT [14], the IUT reports the characteristic value to the Upper Tester.

4.5   Configure indication and notification

- Test Purpose

  This test group verifies compliant operation in response to enable characteristic indication or notification.

- Reference

  [3] 5.3

- Initial Condition

  - The handle of each characteristic value referenced in the Test Cases below has been previously discovered by the IUT during the test procedure in Section 4.4 or is known to the IUT by other means.

  - The handle of the CCCD of each characteristic referenced in the Test Cases below has been previously discovered by the IUT during the test procedure in Section 4.4 or is known to the IUT by other means.

- Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1 if using an LE transport, or Section 4.2.2 if using a BR/EDR transport.

- Test Case Configuration

TCID	Reference	Characteristic	Value
PLXP/COL/CON/BV-01-C [Configure PLX Spot-check Measurement characteristic for Indication]	[3] 5.4	PLX Spot-check Measurement	0x0002
PLXP/COL/CON/BV-02-C [Configure PLX Continuous Measurement characteristic for Notification]	[3] 5.5	PLX Continuous Measurement	0x0001
PLXP/COL/CON/BV-03-C [Configure Record Access Control Point characteristic for Indication]	[3] 5.7	Record Access Control Point (RACP)	0x0002
PLXP/COL/CON/BV-04-C [Configure Current Time characteristic for Notification]	[3] 5.3.4	Current Time	0x0001
PLXP/COL/CON/BV-05-C [Configure Battery Level characteristic for Notification]	[3] 5.3.5	Battery Level	0x0001

Table 4.4: Configure indication and notification test cases

- Test Procedure

   1. The Upper Tester sends a command to the IUT to send a correctly formatted *ATT_Write_Request* (0x12) with the handle of the CCCD and the value from Table 4.4 to the Lower Tester.

- Expected Outcome

   Pass verdict

   If the test case is for indication, the IUT sends a correctly formatted *ATT_Write_Request* (0x12) to the Lower Tester with the handle set to that of the Client Characteristic Configuration descriptor for the characteristic with the value set to «Indication».

   If the test case is for notification, the IUT sends a correctly formatted *ATT_Write_Request* (0x12) to the Lower Tester with the handle set to that of the Client Characteristic Configuration descriptor for the characteristic with the value set to «Notification».

4.6   PLX Spot-check Measurements

The procedures defined in this test group verify implementation of the spot-check measurement characteristics for indication as defined in the Pulse Oximeter Profile Specification [3] by a Pulse Oximeter Sensor IUT, and usage of the same features by a Collector IUT.

PLXP/COL/PLXSC/BV-02-C [Receive PLX Spot-check Measurement Indications]

- Test Purpose

   Verify that the Collector IUT can receive indications of the PLX Spot-check Measurement Characteristic for various field configurations.

- Reference

   [3] 5.4

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  - The IUT has executed the procedure included in PLXP/COL/CON/BV-01-C [Configure PLX Spot-check Measurement characteristic for Indication], which configures it to expect a PLX Spot-check Measurement indication.

  - The IUT knows the handle of the PLX Spot-check Measurement characteristic.

- Test Procedure

  1. The Lower Tester sends only one *ATT_Handle_Value_Indication* containing a PLX Spot-check Measurement characteristic value to the IUT.
  2. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
  3. Verify that the characteristic value meets the requirements of the service.

- Expected Outcome

  Pass verdict

  The reported field values and units match the ones sent by the Lower Tester.

4.7　PLX Continuous Measurements

The procedures defined in this test group verify implementation of the PLX Continuous Measurement characteristic for notifications as defined in the Pulse Oximeter Profile Specification [3] by a Pulse Oximeter Sensor IUT, and usage of the same features by a Collector IUT.

PLXP/COL/PLXC/BV-02-C [Receive PLX Continuous Measurement Notifications]

- Test Purpose

  Verify that the Collector IUT can receive notifications of the PLX Continuous Measurement characteristic for various field configurations.

- Reference

  [3] 5.5

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a PLX Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  - The IUT has executed the procedure included in PLXP/COL/CON/BV-02-C [Configure PLX Continuous Measurement characteristic for Notification], which configures it to expect PLX Continuous Measurement notifications.

  - The IUT knows the handle of the PLX Continuous Measurement characteristic.

- Test Procedure

  1. The Lower Tester sends several *ATT_Handle_Value_Notifications* containing a PLX Continuous Measurement characteristic value to the IUT.
  2. Verify that the characteristic values meet the requirements of the service.

- Expected Outcome

  Pass verdict

  The reported field values and units match the ones sent by the Lower Tester.

  Characteristic values meet the requirements of the service.

4.8 Common Behavior for PLX Features and Bond Management Feature characteristics

This test group contains test cases to verify compliant operation when configuring for indication or reading the PLX Features and Bond Management Feature characteristics upon reconnection.

4.8.1 Read feature characteristic with bonding enabled

- Test Purpose

  Verify that, after the initial connection and bonding, the IUT can read the features characteristic listed in Table 4.5.

- Reference

  [15] 5

- Initial Condition

  - For each test case in Table 4.5, the Upper Tester knows the handle of the features characteristic contained in the Lower Tester.

  - Establish an ATT Bearer connection between the Lower Tester and the IUT as described in Section 4.2.1, if using an LE transport, or 4.2.2 if using a BR/EDR transport.

  - The IUT is bonded with the Lower Tester.

- Test Case Configuration

Test Case	Reference	Feature characteristic
PLXP/COL/PLXF/BV-02-C [Read PLX Feature characteristic - Bonding enabled]	[15] 5.6	PLX Feature characteristic
PLXP/COL/BMS/BV-07-C [Read Bond Management Feature characteristic]	[15] 5.8.5	Bond Management Feature characteristic

Table 4.5: Read Feature characteristics with bonding enabled

- Test Procedure

  1. The Upper Tester commands the IUT to read the Feature characteristic, listed in Table 4.5, from the Lower Tester.
  2. The IUT sends an *ATT_Read_Request* to the Lower Tester containing the handle specified by the Upper Tester.
  3. The Lower Tester receives the *ATT_Read_Request* and then sends an *ATT_Read_Response* to the IUT containing the value of the characteristic.
  4. The IUT receives the *ATT_Read_Response* and reports the value to the Upper Tester.

- Expected Outcome

  Pass verdict

  The IUT reads the Feature characteristic, listed in Table 4.5, and reports its value to the Upper Tester.

  Reserved for future use bit values are ignored.

4.8.2   Enable feature characteristic for indication or read feature characteristic upon reconnection

- Test Purpose

  Verify that, for each test case in Table 4.6, the IUT can either enable for indication the Feature characteristic or read the characteristic upon reconnection.

- Reference

  [15] 5

- Initial Condition

  - For each test case in Table 4.6, the handles of the Feature characteristic and Client Characteristic Configuration descriptors have been previously discovered by the Upper Tester during the test procedure in Section 4.4 or are known to the Upper Tester by other means.

  - Establish an ATT Bearer connection between the Lower Tester and the IUT as described in Section 4.2.1, if using an LE transport, or 4.2.2 if using a BR/EDR transport.

  - The IUT is not paired and bonded with the Lower Tester.

- Test Case Configuration

Test Case	Reference	Feature characteristic
PLXP/COL/PLXF/BV-03-C [Enable PLX Features characteristic for indication or read characteristic upon reconnection]	[15] 5.6	PLX Features characteristic
PLXP/COL/BMS/BV-08-C [Enable Bond Management Feature characteristic for indication or read characteristic upon reconnection]	[15] 5.8.5	Bond Management Feature characteristic

Table 4.6: Enable Feature characteristic for indication or read characteristic upon reconnection

- Test Procedure

  1. The Upper Tester orders the IUT to initiate pairing and bonding.
  2. The Upper Tester commands the IUT to perform, either alternative 2A or 2B:

     Alternative 2A (Configure the Feature characteristic, listed in Table 4.6, for indication):
     2A.1.   The IUT configures the Feature characteristic for indication.

     Or,

     Alternative 2B (Read the Feature characteristic, listed in Table 4.6, upon reconnection):
     2B.1.   The Upper Tester commands the IUT to disconnect, and the IUT terminates the connection with the Lower Tester.

2B.2.   The Upper Tester commands the IUT to reconnect to the Lower Tester.

2B.3   The IUT reads the Feature characteristic from the Lower Tester and reports the value to the Upper Tester.

- Expected Outcome

   Pass verdict

   In step 1, The IUT successfully completes pairing and bonding.

   In step 2A.1, the IUT enables the Feature characteristic for indication.

   In step 2B.3, the IUT reads the Feature characteristic and reports its value to the Upper Tester.

   Reserved for future use bit values are ignored

4.9   Record Access – Report Stored Records

This test group contains test cases to verify compliant operation when the Record Access Control Point (RACP) 'Report Stored Records' procedure is used.

PLXP/COL/RAR/BV-01-C [Report Stored Records – 'All records']

- Test Purpose

   Verify that the Collector IUT can perform the 'Report Stored Records' procedure with an Operator of 'All records', as well as verify that measurements that are successfully indicated are not sent again.

- Reference

   [3] 5.7.2.3

- Initial Condition

   - Perform the preamble described in Section 4.2.3.

- Test Procedure

   1. Perform an action on the Lower Tester that will induce it to generate 3 records.
   2. Verify that a connection between the Lower Tester and IUT is established.
   3. The IUT writes the 'Report Stored Records' Op Code (0x01) to the RACP using an Operator of 'All records' (0x01) and no Operand.
   4. The Lower Tester sends 3 *ATT_Handle_Value_Indications* of the PLX Spot-check Measurement characteristic.
   5. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
   6. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the 'Response Code' Op Code (0x06) an Operator of Null (0x00) and an Operand representing Request Op Code (0x01) followed by the Response Code for 'Success' (0x01).
   7. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
   8. Verify that the characteristic values meet the requirements of the service.
   9. The IUT writes the 'Report Stored Records' Op Code (0x01) to the RACP using an Operator of 'All records' (0x01) and no Operand.
   10. The Lower Tester sends zero *ATT_Handle_Value_Indications* of the PLX Spot-check Measurement characteristic.
   11. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the 'Response Code' Op Code (0x06) an Operator of Null (0x00) and an

Operand representing Request Op Code (0x01) followed by the Response Code for 'Success' (0x01).

12. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.

- Expected Outcome

Pass verdict

The IUT receives 3 of the PLX Spot-check Measurement characteristic on the first request.

The PLX Measurement characteristic contains the values of the three records.

The IUT receives the Response Code for 'Success' (0x01).

The oldest record is transmitted before newer records.

The IUT sends no indications PLX Spot-check Measurement characteristic on the second request to show they will not be transmitted again.

The IUT receives the Response Code for 'Success' (0x01).

PLXP/COL/RAR/BV-02-C [Report Stored Records – 'No Records Found']

- Test Purpose

Verify that the Collector IUT can perform the 'Report Stored Records' procedure with an Operator of 'All records' when the Sensor responds with 'No Records Found'.

- Reference

[3] 5.7.2.1

- Initial Condition

    - Perform the preamble described in Section 4.2.3.

- Test Procedure

    1. Perform an action on the Lower Tester that will induce it to contain no stored records.
    2. Verify that a connection between the Lower Tester and IUT is established.
    3. The IUT writes the 'Report Stored Records' Op Code (0x01) to the RACP using an Operator of 'All records' (0x01) and no Operand.
    4. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the 'Response Code' Op Code (0x06) an Operator of Null (0x00) and an Operand representing Request Op Code (0x01) followed by the Response Code for 'No Records Found' (0x06).
    5. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.

- Expected Outcome

Pass verdict

The IUT receives the Response Code for 'No Records Found' (0x06).

4.10   Record Access - Delete Stored Records

This test group contains test cases to verify compliant operation when the Record Access Control Point (RACP) 'Delete Stored Records' procedure is used.

PLXP/COL/RAD/BV-01-C [Delete Stored Records – 'All records']

- Test Purpose

  Verify that the Collector IUT can perform the 'Delete Stored Records' procedure with an Operator of 'All records''.

- Reference

  [3] 5.7.2.2

- Initial Condition

  - Perform the preamble described in Section 4.2.3.

- Test Procedure

  1. Perform an action on the Lower Tester that will induce it to generate 3 records.
  2. Verify that a connection between Lower Tester and IUT is established.
  3. The IUT writes the 'Report Number of Stored Records' Op Code (0x04) to the RACP using an Operator of 'All records' (0x01) and no Operand.
  4. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the 'Report Number of stored Records' response Op Code (0x05) an Operator of Null (0x00) and an Operand representing that three records were found (0x0003).
  5. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
  6. The IUT writes the 'Delete Stored Records' Op Code (0x02) to the RACP using an Operator of 'All records' (0x01) and no Operand.
  7. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the Response Code Op Code (0x06) an Operator of Null (0x00) and an Operand representing Request Op Code (0x02) followed by the Response Code for 'Success' (0x01).
  8. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
  9. The IUT writes the 'Report Number of Stored Records' Op Code (0x04) to the RACP using an Operator of 'All records' (0x01) and no Operand.
  10. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the 'Report Number of stored Records' response Op Code (0x05) an Operator of Null (0x00) and an Operand representing that zero records were found (0x0000).
  11. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.

- Expected Outcome

  Pass verdict

  The number of stored records is changed to zero after the delete operation.

4.11 Record Access - Abort Operation

This test group contains test cases to verify compliant operation when the Record Access Control Point (RACP) 'Abort Operation' procedure is used.

PLXP/COL/RAA/BV-01-C [Abort Operation – 'Report Stored Records']

- Test Purpose

  Verify that the Collector IUT can perform an Abort of the Report Stored Records procedure.

- Reference

  [3] 5.7.2.4

- Initial Condition

  - Perform the preamble described in Section 4.2.3.

- Test Procedure

  1. Perform an action on the Lower Tester that will induce it to generate enough records such that the transmission is not able to complete before the RACP abort is attempted. In most cases ~200 records is sufficient since this will take over 5 seconds to transfer. Alternatively, the IUT could transmit the records slowly.
  2. Verify that a connection between Lower Tester and IUT is established.
  3. IUT writes the 'Report Stored Records' Op Code (0x01) to the RACP using an Operator of 'All records' (0x01) and no Operand.
  4. The Lower Tester starts to send number of indications of the PLX Spot-check Measurement characteristic.
  5. The IUT receives one or more *ATT_Handle_Value_Indication* from the Lower Tester containing the PLX Spot-check Measurement characteristic handle and value.
  6. IUT writes the 'Abort Operation' Op Code (0x03) to the RACP with an Operator of Null and no Operand.
  7. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the 'Response Code' Op Code (0x06) an Operator of Null (0x00) and an Operand representing Request Op Code (0x03) followed by the Response Code for 'Success' (0x01).
  8. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
  9. Verify that the PLX Spot-check Measurement indications stop.
  10. Verify that the characteristic value meets the requirements of the service.

- Expected Outcome

  Pass verdict

  The IUT receives some, but not all indications of the PLX Spot-check Measurement characteristic. The IUT receives one indication of the Record Access Control Point characteristic with the 'Response Code' Op Code (0x06) an Operator of Null (0x00) and an Operand representing Request Op Code (0x03) followed by the Response Code for 'Success' (0x01).

4.12 Record Access – Report Number of Stored Records

This test group contains test cases to verify compliant operation when the Record Access Control Point (RACP) 'Report Number of Stored Records' procedure is used.

PLXP/COL/RAN/BV-01-C [Report Number of Stored Records – 'All records']

- Test Purpose

  Verify that the Collector IUT can perform the 'Report Number of Stored Records' procedure with an Operator of 'All records'.

- Reference

  [3] 5.7.2.1

- Initial Condition

  - Perform the preamble described in Section 4.2.3.

- Test Procedure

  1. Perform an action on the Lower Tester that will induce it to generate 3 records.
  2. Verify that a connection between Lower Tester and IUT is established.
  3. The IUT writes the 'Report Number of Stored Records' Op Code (0x04) to the RACP using an Operator of 'All records' (0x01) and no Operand.
  4. The Lower Tester sends an *ATT_Handle_Value_Indication* of the Record Access Control Point characteristic with the 'Report Number of stored Records' response Op Code (0x05) an Operator of Null (0x00) and an Operand representing that three records were found (0x0003).
  5. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
  6. Verify that the characteristic value meets the requirements of the service.

- Expected Outcome

  Pass verdict

  The IUT receives one indication of the Record Access Control Point characteristic with the 'Report Number of stored Records' Response Op Code (0x05) an Operator of Null (0x00) and an Operand representing that three records were found (0x0003).

4.13 Record Access- Error Handling

RACP error handling is covered in the Pulse Oximeter Service Test Suite [12].

4.14 Record Access – 'Procedure Timeout'

This test group contains test cases to verify compliant operation when the Lower Tester uses Control Point procedures and a procedure timeout occurs.

PLXP/COL/RAT/BI-01-C [Procedure Timeout Handling]

- Test Purpose

  Verify that if the Collector IUT does not receive a response to a RACP Op Code, it will time out after the Attribute Protocol Timeout.

- Reference

  [3] 5.7.2.6

- Initial Condition

  Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  Perform the preamble described in Section 4.2.3.

- Test Procedure

  1. Create a stored record with at least one PLX Spot-check Measurement characteristic value.
  2. Verify that a connection between the Lower Tester and IUT is established.
  3. The IUT writes e.g., the 'Report Stored Records' Op Code (0x01) to the RACP, using an Operator of 'All records' (0x01) and no Operand.
  4. The Lower Tester does NOT send an indication of the Record Access Control Point characteristic for at least longer than the Attribute Protocol Timeout.
  5. After the specified timeout the IUT sends a notification of the Attribute Transaction Timeout to the Upper Tester, and the IUT and considers the procedure to have failed.

- Expected Outcome

  <u>Pass verdict</u>

  After the Attribute Protocol Timeout, the IUT notifies the local upper layer of the time out.

  The IUT returns to a stable state and can process commands normally.

4.15   BMS Procedures

This test group contains test cases to verify compliant operation when the Bond Management Control Point procedures are used.

Table 3.3 in [11] defines the Op Codes and parameter values used in the test procedures in this section.

PLXP/COL/BMS/BV-01-C [Write BMSCP characteristic value]

- Test Purpose

  Verify that a Collector IUT can write the BMSCP characteristic using ATT Write Request.

- Reference

  [11] 3.1.1

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

- Test Procedure

  The following test procedure has to be repeated for each defined Op Code in Table 3.3 in [11] valid for the used transport:

  1. The Upper Tester commands the IUT to sends an *ATT_Write_Request* to the Lower Tester with the handle and the value of the BMSCP characteristic and a value containing an Op code as defined in Table 3.3 in [11].
  2. The Lower Tester receives the *ATT_Write_Request* and then sends an *ATT_Write_Response* to the IUT.

- Expected Outcome

  Pass verdict

  The IUT receives an *ATT_Write_Response* from the Lower Tester.

  Upon receiving an *ATT_Write_Response* from the Lower Tester the IUT sends the result to the Upper Tester.

PLXP/COL/BMS/BV-02-C [Write BMSCP characteristic value – with Parameter]

- Test Purpose

  Verify that a Collector IUT can write the BMSCP characteristic with data larger than Op Code, using ATT Write Request.

- Reference

  [11] 3.1.1

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

- Test Procedure

  The following test procedure has to be repeated for each Op Code in Table 3.3 in [11] valid for the used transport:

  1. The Upper Tester commands the IUT to sends an *ATT_Write_Request* to the Lower Tester with the handle and the value of the BMSCP characteristic and a value containing an Op code as defined in Table 3.3 in [11] and a parameter value containing a value which fits within the used MTU size.
  2. The Lower Tester receives the *ATT_Write_Request* and then sends an *ATT_Write_Response* to the IUT.

- Expected Outcome

  Pass verdict

  The IUT receives an *ATT_Write_Response* from the Lower Tester.

  The parameter value received by the Lower Tester corresponds to the value sent by IUT.

  Upon receiving an *ATT_Write_Response* from the Lower Tester the IUT sends the result to the Upper Tester.

PLXP/COL/BMS/BV-03-C [Write BMSCP characteristic value – Insufficient Authorization]

- Test Purpose

  Verify that a Collector IUT can write the BMSCP characteristic with an invalid or missing authorization code, using ATT Write Request.

- Reference

  [11] 3.1.1

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

- Test Procedure

  The following test procedure has to be repeated for each Op Code in Table 3.3 in [11] valid for the used transport.

  1. Verify that a connection between the Lower Tester and IUT is established.
  2. The IUT sends an *ATT_Write_Request* with the handle of the BMSCP characteristic and a value containing an Op code as defined in Table 3.3 in [11] and a parameter value containing a value which fits within the used MTU size. The value does not contain the required authorization code.
  3. The IUT receives an *ATT_Error_Response* with the Error Code set to 'Insufficient Authorization' from the Lower Tester.
  4. Verify that the IUT considers the procedure to have failed.

- Expected Outcome

  Pass verdict

  The IUT receives an *ATT_Error_Response* with the Error Code set to 'Insufficient Authorization' from the Lower Tester.

  Upon receiving an *ATT_Error_Response* from the Lower Tester the IUT sends the result to the Upper Tester and returns to a stable state and can process commands normally.

PLXP/COL/BMS/BI-04-C [Write BMSCP characteristic value – Operation Failed]

- Test Purpose

  Verify that a Collector IUT behaves appropriately when it receives an 'Operation Failed' Error Response.

- Reference

  [11] 3.1.1

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

- Test Procedure

  The following test procedure has to be repeated for one of the Op Codes in Table 3.3 in [11] valid for the used transport.

  1. Verify that a connection between the Lower Tester and IUT is established.
  2. The IUT sends an *ATT_Write_Request* with the handle of the BMSCP characteristic and a value containing an Op code without parameter value as defined in Table 3.3 in [11].
  3. The IUT receives an *ATT_Error_Response* with the Error Code set to 'Operation Failed' from the Lower Tester.
  4. Verify that the IUT considers the procedure to have failed.

- Expected Outcome

Pass verdict

The IUT receives an *ATT_Error_Response* with the Error Code set to 'Operation Failed' from the Lower Tester.

Upon receiving an *ATT_Error_Response* from the Lower Tester the IUT sends the result to the Upper Tester and returns to a stable state and can process commands normally.

PLXP/COL/BMS/BI-05-C [Write BMSCP characteristic value – Op Code not supported]

- Test Purpose

Verify that a Collector IUT behaves appropriately when it receives an 'Op Code not supported' Error Response.

- Reference

[11] 3.1.1

- Initial Condition

    - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

- Test Procedure

    1. Verify that a connection between the Lower Tester and IUT is established.
    2. The IUT sends an *ATT_Write_Request* with the handle of the BMSCP characteristic and a value containing a valid Op code value.
    3. The IUT receives an *ATT_Error_Response* with the Error Code set to 'Op Code not Supported' from the Lower Tester.
    4. Verify that the IUT considers the procedure to have failed.

- Expected Outcome

Pass verdict

The IUT receives an *ATT_Error_Response* with the Error Code set to 'Op Code not Supported' from the Lower Tester.

Upon receiving an *ATT_Error_Response* from the Lower Tester the IUT sends the result to the Upper Tester and returns to a stable state and can process commands normally.

PLXP/COL/BMS/BV-06-C [Write Long BMSCP characteristic value]

- Test Purpose

Verify that a Collector IUT can write a long characteristic value to the BMSCP characteristic.

- Reference

[11] 3.1.1

- Initial Condition

Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

The length of the parameter used is higher than the used MTU size.

- Test Procedure

The following test procedure has to be executed for one of the Op Codes in Table 3.3 in [11] valid for the used transport.

1. The Upper Tester commands the IUT to execute the GATT Characteristic Value Reliable Writes sub-procedure with the handle and the value of the BMSCP characteristic.

- Expected Outcome

Pass verdict

The IUT sends a correctly formatted *ATT_Prepare_Write_Request* to the Lower Tester.

The IUT receives an *ATT_Execute_Write_Response* from the Lower Tester.

The IUT sends a correctly formatted *ATT_Execute_Write_Request* to the Lower Tester.

Upon receiving an *ATT_Execute_Write_Response* from the Lower Tester the IUT sends the result to the Upper Tester.

The characteristic value received by the Lower Tester meets the requirements of the service.

4.16   Current Time Service Features

PLXP/COL/CTS/BV-02-C [Read Current Time Characteristic]

- Test Purpose

Verify that the Collector IUT can read the Current Time characteristic from a Pulse Oximeter Sensor.

- Reference

[3] 5.3.4

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  - The Upper Tester knows the handle of a Current Time characteristic contained in the Lower Tester.

- Test Procedure

  1. Send a command from Upper Tester to request IUT to read a Current Time characteristic from the Lower Tester.
  2. After receipt of the expected result by the Lower Tester from the IUT, send an *ATT_Read_Response* (0x0B) from the Lower Tester to the IUT containing a defined value of the Current Time characteristic.

- Expected Outcome

Pass verdict

The IUT sends a correctly formatted *ATT_Read_Request* (0x0A) to the Lower Tester, containing the handle specified by the Upper Tester.

The IUT receives the response from the Lower Tester and sends the response containing the correct Date Time value to the Upper Tester.

PLXP/SEN/CTS/BV-03-C [Verify that the timestamp in the PLX Spot-check Measurement characteristic agrees with the Current Time Service value]

- Test Purpose

Verify that the value of the Time Stamp field provided in the PLX Spot-check Measurement characteristic is the same as the value of the Date Time field within the Current Time characteristic, within a small tolerance.

- Reference

[3] 5.3.1.1

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a PLX Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  - If IUT permissions for the PLX Spot-check Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.

  - The handle of each characteristic value referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.

- Test Procedure

  1. The Lower Tester configures the PLX Spot-check Measurement characteristic for indication.
  2. Perform an action on the IUT that will induce it to send an indication of the PLX Spot-check Measurement characteristic along with the Time Stamp field.
  3. The IUT receives an *ATT_Handle_Value_Indication* from the Lower Tester containing the PLX Spot-check Measurement characteristic handle and value including the Time Stamp field.
  4. The IUT sends an *ATT_Handle_Value_Confirmation* to the Lower Tester.
  5. Immediately upon receiving the *ATT_Handle_Value_Indication*, the IUT sends an *ATT_Read_Request* to the Lower Tester containing the handle of the Current Time Characteristic.
  6. Compare the timestamp value reported in the PLX Spot-check Measurement characteristic indication received at step #3 with the time value reported in the Current Time characteristic received at step #5.

- Expected Outcome

Pass verdict

The difference between the two time values compared is less than or equal to one second.

4.17   Battery Service Features

PLXP/COL/BAS/BV-02-C [Read Battery Level Characteristic]

* Test Purpose

  Verify that the Collector IUT can read the Battery Level characteristic from a Pulse Oximeter Sensor.

* Reference

  [3] 5.3.5

* Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and IUT and run the preamble procedure for the Collector to initiate connection to a Pulse Oximeter Sensor included in Section 4.2.4 if using an LE transport or 4.2.5 if using a BR/EDR transport.

  - The Upper Tester knows the handle of a Battery Level characteristic contained in the Lower Tester.

* Test Procedure

  1. Send a command from Upper Tester to request IUT to read the Battery Level characteristic from the Lower Tester.
  2. After receipt of the expected result by the Lower Tester from the IUT, send an *ATT_Read_Response* (0x0B) from the Lower Tester to the IUT containing a defined value of the Battery Level characteristic.

* Expected Outcome

  <u>Pass verdict</u>

  The IUT sends a correctly formatted *ATT_Read_Request* (0x0A) to the Lower Tester, containing the handle specified by the Upper Tester.

  The IUT receives the response from the Lower Tester and sends the response containing the correct Battery Level value to the Upper Tester.

4.18   Connection Establishment

This test group contains test cases to verify the compliant behavior of a Pulse Oximeter Sensor in bonded and unbonded situations.

PLXP/COL/CECC/BV-01-C [Lost Bond Procedure when using LE transport]

* Test Purpose

  Verify that the Collector IUT starts encryption with a bonded Pulse Oximeter Sensor on reconnection and rediscovers and reconfigures the Pulse Oximeter Sensor if bond is lost.

* Reference

  [3] 6.2.1

* Initial Condition

  - The IUT and the Lower Tester have previously bonded.

  - Perform the preamble procedure described in Section 4.2.3 to enable indications and notifications on the required characteristics of the Lower Tester's Pulse Oximeter Service.

- No connection is established between the IUT and Lower Tester.

- The bond is deleted at the Lower Tester.

- Test Procedure

  1. The Lower Tester begins advertising using a GAP undirected connectable mode.
  2. The IUT establishes a connection to the Lower Tester.
  3. Verify that the IUT starts encryption when the connection is established and rediscovers and reconfigures the Pulse Oximeter Sensor upon detection of the lost bond.

- Expected Outcome

  Pass verdict

  The IUT starts encryption when the connection is established.

  The IUT rediscovers the Pulse Oximeter Service.

  The IUT reconfigures the Client Characteristics Configuration descriptors of the PLX Spot-check Measurement characteristic, PLX Continuous Measurement characteristic, the Record Access Control Point characteristic.

PLXP/COL/CECC/BV-02-C [Lost Bond Procedure when using BR/EDR transport]

- Test Purpose

  Verify that the Collector IUT reconfigures the Pulse Oximeter Sensor if bond is lost.

  In case of BR/EDR, either the Lower Tester or Collector IUT could initiate a connection when they are bonded. The device initiating the connection becomes a Central and is referred here as "Central to be" and the device accepting the connection becomes a Peripheral and is referred here as "Peripheral to be". Verify that the "Central to be" starts encryption with a bonded "Peripheral to be" on connection.

- Reference

  [3] 6.3.3

- Initial Condition

  - The IUT and the Lower Tester have previously bonded.

  - No connection is established between the IUT and Lower Tester.

  - The bond is deleted at the Lower Tester.

- Test Procedure

  1. The "Peripheral to be" is in connectable mode.
  2. The "Central to be" establishes a connection to the "Peripheral to be".
  3. The "Central to be" starts encryption when the connection is established.
  4. Verify that the IUT rediscovers and reconfigures the Pulse Oximeter Sensor upon detection of the lost bond.

- Expected Outcome

  Pass verdict

  The "Central to be" starts encryption when the connection is established.

  The IUT rediscovers the Pulse Oximeter Service.

The IUT reconfigures the Client Characteristics Configuration descriptors of the PLX Spot-check Measurement characteristic, PLX Continuous Measurement characteristic, the Record Access Control Point characteristic.

5 Test case mapping

The Test Case Mapping Table (TCMT) maps test cases to specific requirements in the ICS. The IUT is tested in all roles for which support is declared in the ICS document.

The columns for the TCMT are defined as follows:

Item: Contains a logical expression based on specific entries from the associated ICS document. Contains a logical expression (using the operators AND, OR, NOT as needed) based on specific entries from the applicable ICS document(s). The entries are in the form of y/x references, where y corresponds to the table number and x corresponds to the feature number as defined in the ICS document for Pulse Oximeter Profile [5].

Feature: A brief, informal description of the feature being tested.

Test Case(s): The applicable test case identifiers are required for Bluetooth Qualification if the corresponding y/x references defined in the Item column are supported. Further details about the function of the TCMT are elaborated in [2].

For the purpose and structure of the ICS/IXIT, refer to [2].

Item	Feature	Test Case(s)
PLXP 3/3	Pulse Oximeter Service UUID in AD over LE	PLXP/SEN/PLXS/BV-01-C
PLXP 3/4	Local Name included in AD or Scan Response over LE	PLXP/SEN/PLXS/BV-02-C
PLXP 3/5	Appearance included in AD or Scan Response over LE	PLXP/SEN/PLXS/BV-03-C
PLXP 1/2	Discover Pulse Oximeter Service and characteristics	PLXP/COL/CGGIT/SER/BV-01-C PLXP/COL/CGGIT/CHA/BV-01-C PLXP/COL/CGGIT/CHA/BV-02-C PLXP/COL/CGGIT/CHA/BV-03-C
PLXP 9/7 AND PLXP 9/8	Discover Record Access Control Point Characteristic	PLXP/COL/CGGIT/CHA/BV-04-C
PLXP 8/4	Discover Current Time Service and characteristic	PLXP/COL/CGGIT/SER/BV-03-C PLXP/COL/CGGIT/CHA/BV-05-C
PLXP 8/2	Discover Device Information Service	PLXP/COL/CGGIT/SER/BV-02-C
PLXP 8/5	Discover Battery Service and characteristic	PLXP/COL/CGGIT/SER/BV-05-C PLXP/COL/CGGIT/CHA/BV-08-C
PLXP 8/3	Discover Bond Management Service	PLXP/COL/CGGIT/SER/BV-04-C
PLXP 2/2 AND PLXP 3/1 AND (NOT PLXP 2/1) AND GATT 1a/4	Pulse Oximeter Service not discoverable over BR/EDR	PLXP/SEN/SGGIT/SDPNF/BV-01-C
PLXP 2/2 AND PLXP 3/6 AND (NOT PLXP 2/1) AND GATT 1a/4	Device Information Service not discoverable over BR/EDR	PLXP/SEN/SGGIT/SDPNF/BV-02-C
PLXP 2/2 AND PLXP 3/8 AND (NOT PLXP 2/1) AND GATT 1a/4	Current Time Service not discoverable over BR/EDR	PLXP/SEN/SGGIT/SDPNF/BV-03-C

Item	Feature	Test Case(s)
PLXP 2/2 AND PLXP 3/7 AND (NOT PLXP 2/1) AND GATT 1a/4	Bond Management Service not discoverable over BR/EDR	PLXP/SEN/SGGIT/SDPNF/BV-04-C
PLXP 2/2 AND PLXP 3/9 AND (NOT PLXP 2/1) AND GATT 1a/4	Battery Service not discoverable over BR/EDR	PLXP/SEN/SGGIT/SDPNF/BV-05-C
PLXP 12/1	Discover and Read Device Information Service Characteristics	PLXP/COL/PLXSD/BV-19-C PLXP/COL/PLXSD/BV-20-C
PLXP 13/1	Discover Bond Management Service characteristics	PLXP/COL/CGGIT/CHA/BV-06-C PLXP/COL/CGGIT/CHA/BV-07-C
PLXP 10/1	Configure PLX Spot-check Measurement Characteristic for Indication	PLXP/COL/CON/BV-01-C
PLXP 10/2	Receive PLX Spot-check Measurement Indications	PLXP/COL/PLXSC/BV-02-C
PLXP 10/3	Configure PLX Continuous Measurement Characteristic for Notification	PLXP/COL/CON/BV-02-C
PLXP 10/4	Receive PLX Continuous Measurement Notifications	PLXP/COL/PLXC/BV-02-C
PLXP 10/5	Configure Record Access Control Point characteristic for Indication	PLXP/COL/CON/BV-03-C
PLXP 10a/1	Characteristic GGIT – PLX Features indication	PLXP/COL/CGGIT/ISFC/BV-01-C
PLXP 10a/2	Read PLX Feature characteristic - Bonding enabled	PLXP/COL/PLXF/BV-02-C
PLXP 10a/1 OR PLXP 10a/2	Enable PLX Features characteristic for indication or read characteristic upon reconnection	PLXP/COL/PLXF/BV-03-C
PLXP 10a/3	Characteristic GGIT – Bond Management Feature indication	PLXP/COL/CGGIT/ISFC/BV-02-C
PLXP 10a/4	Read Bond Management Feature characteristic	PLXP/COL/BMS/BV-07-C
PLXP 10a/3 OR PLXP 10a/4	Enable Bond Management Feature characteristic for indication or read characteristic upon reconnection	PLXP/COL/BMS/BV-08-C
PLXP 10/10	Report Stored Records – 'All records' Procedure Timeout Handling	PLXP/COL/RAR/BV-01-C PLXP/COL/RAR/BV-02-C PLXP/COL/RAT/BI-01-C
PLXP 10/9	Delete Stored Records – 'All records'	PLXP/COL/RAD/BV-01-C
PLXP 10/11	Abort Operation – 'Report Stored Records'	PLXP/COL/RAA/BV-01-C
PLXP 10/8	Report Number of Stored records – 'All Records'	PLXP/COL/RAN/BV-01-C

Item	Feature	Test Case(s)
PLXP 13/2	Write BMSCP characteristic value	PLXP/COL/BMS/BV-01-C PLXP/COL/BMS/BV-02-C PLXP/COL/BMS/BV-03-C PLXP/COL/BMS/BI-04-C PLXP/COL/BMS/BI-05-C PLXP/COL/BMS/BV-06-C
PLXP 15/4	Configure Current Time Characteristic for Notification	PLXP/COL/CON/BV-04-C
PLXP 15/2	Read Current Time Characteristic	PLXP/COL/CTS/BV-02-C
PLXP 3/8 AND PLXP 3/15	Verify that the timestamp in the PLX Spot-check Measurement characteristic agrees with the Current Time Service value	PLXP/SEN/CTS/BV-03-C
PLXP 14/3	Configure Battery Level Characteristic for Notifications	PLXP/COL/CON/BV-05-C
PLXP 14/2	Read Battery Level Characteristic	PLXP/COL/BAS/BV-02-C
PLXP 2/2 AND PLXP 1/2	Lost Bond Procedure when using LE transport	PLXP/COL/CECC/BV-01-C
PLXP 2/1 AND PLXP 1/2	Lost Bond Procedure when using BR/EDR transport	PLXP/COL/CECC/BV-02-C

Table 5.1: Test case mapping

6 Revision history and acknowledgments

Revision History

Publication Number	Revision Number	Date	Comments
0	1.0.0	2015-07-21	Prepare for publication
	1.0.1r00	2016-05-16	Converted to new Test Case ID conventions as defined in TSTO v4.1.
	1.0.1r01	2016-06-01	Review by Miles Smith
1	1.0.1	2016-07-14	Prepared for TCRL 2016-1 publication.
	1.0.2r00	2017-08-21	TSE 9551: For PLXP/COL/BMS/BI-05-I, updated Test Procedure text.
	1.0.2r01	2017-09-22	Template update.
	1.0.2r02	2017-10-13	TSE 9875: Revised PLXP/SEN/CTS/BV-03-I in the TCMT.
2	1.0.2	2017-11-28	Approved by BTI. Prepared for TCRL 2017-2 publication.
	p3r00–r10	2021-02-21 – 2021-12-23	TSE 16766 (rating 4): Added new test group ISFC. New test cases added: PLXP/COL/CGGIT/ISFC/BV-01-C and-02-C, PLXP/COL/PLXF/BV-02-I and -03-I, and PLXP/COL/BMS/BV-07-I -08-I (E16277). Updated TCMT accordingly. TSE 18109 (rating 2): Converted the following test cases into GGIT tests: PLXP/COL/PLXF/BV-01-I, PLXP/COL/PLXSD/BV-01-I – -06-C and 12-C – -18-I and -21-I – -26-I, and PLXP/SEN/PLXSD/BV-07-I – -11-C. The new GGIT converted TCIDs are: PLXP/COL/CGGIT/SER/BV-01-C – -05-C, PLXP/SEN/SGGIT/SDPNF/BV-01-C – -05-C, PLXP/COL/CGGIT/CHA/BV-01-C – -08-C. Updated TCMT accordingly. TSE 18110 (rating 4): Introduced new Section 4.5, Configure indication and notification, test group and removed legacy configuration of indication and notification test cases: PLXP/COL/CON/BV-01-I replaces PLXP/COL/PLXSC/BV-01-I, PLXP/COL/CON/BV-02-I replaces PLXP/COL/PLXC/BV-01-I, added new test case PLXP/COL/CON/BV-03-I, PLXP/COL/CON/BV-04-I replaces PLXP/COL/CTS/BV-01-I, PLXP/COL/CON/BV-05-I replaces PLXP/COL/BAS/BV-01-I. Updated TCMT accordingly. TSE 18111 (rating 1): Removed direct references to GATT test cases in the following test cases: PLXP/COL/PLXSD/BV-19-I and -20-I, PLXP/SEN/CTS/BV-03-I, and PLXP/COL/BMS/BV-01-I, -02-I, and -06-I. Also, added IXIT reference and updated PLXP/COL/PLXSD/BV-19-I and -20-I to referece the DIS characteristcs from IXIT. TSE 18112 (rating 1): In Section 4.2.5.2 and PLXP/COL/CECC/BV-02-I updated "master" with "Central", "slave" with "Peripheral" (E15807).

Publication Number	Revision Number	Date	Comments
			Performed editorial work, including updating to the latest TS template and aligning the copyright page with v2 of the DNMD.
3	p3	2022-01-25	Approved by BTI on 2022-01-06. Prepared for TCRL 2021-2 publication.
	p4r00	2023-11-01	TSE 23281 (rating 1): Converted -I tests to -C tests as appropriate; updated the TCMT and TCRL accordingly. Performed other editorials to align the document with the latest TS template, including updates to the Test Strategy, conformance, Pass/Fail verdict conventions, and TCMT introductory text. Deleted draft revision history comments prior to p0.
4	p4	2024-07-01	Approved by BTI on 2024-04-21. Prepared for TCRL 2024-1 publication.