

Heart Rate Service (HRS)

Bluetooth® Test Suite

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1 Scope

This Bluetooth document contains the Test Suite Structure (TSS) and test cases to test the implementation of the Bluetooth Heart Rate Service 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.

- [1] Test Strategy and Terminology Overview
- [2] Bluetooth Core Specification, Version 4.0 or later
- [3] Heart Rate Service Specification, Version 1.0
- [4] ICS Proforma for Heart Rate Service
- [5] GATT Test Suite, GATT.TS
- [6] Characteristic and Descriptor descriptions are accessible via the [Bluetooth SIG Assigned Numbers](#)

2.2 Definitions

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

2.3 Abbreviations

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

3 Test Suite Structure (TSS)

3.1 Overview

The Heart Rate Service requires the presence of GAP, SM, and GATT. This is illustrated in [Figure 3.1](#).

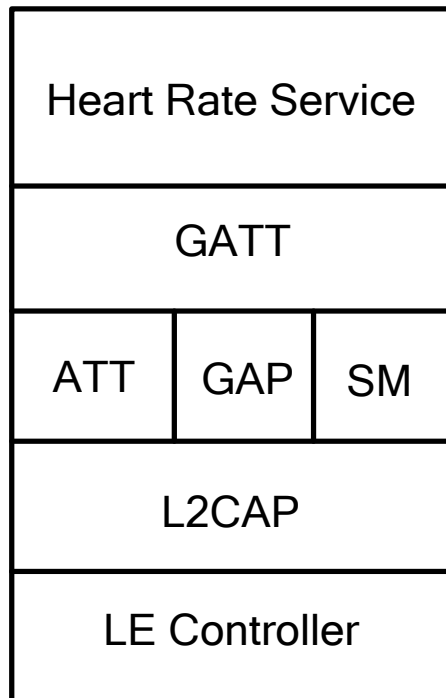


Figure 3.1: Heart Rate Service Test Model

3.2 Test Strategy

The test objectives are to verify functionality of the Heart Rate Service 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 [4]. 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:

- Generic GATT Integrated Tests
- Characteristic Read
- Characteristic Write
- Configure Notification
- Characteristic Notification

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 [5] referred to as Generic GATT Integrated Tests (GGIT); when used, the GGIT tests 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>
HRS	Heart Rate Service
Identifier Abbreviation	Role Identifier <IUT role>
SEN	Sensor role
Identifier Abbreviation	Reference Identifier <GGIT test group>
SGGIT	Server Generic GATT Integrated Tests
Identifier Abbreviation	Reference Identifier <GGIT class>
CHA	Characteristic
SER	Service
Identifier Abbreviation	Feature Identifier <feat>
CN	Characteristic Notification
CON	Configure Notification
CR	Characteristic Read
CW	Characteristic Write

Table 4.1: HRS 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 Launch Studio, 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

Follow the preamble procedure described in [\[5\]](#) Section 4.2.1.2 with the IUT operating in the Peripheral role.

4.3 Generic GATT Integrated Tests

Execute the Generic GATT Integrated Tests defined in Section 6.3, Server test procedures (SGGIT), in [5] using Table 4.2 below as input:

TCID	Service / Characteristic	Reference	Properties	Value Length (Octets)	Service Type
HRS/SEN/SGGIT/SER/BV-01-C [Service GGIT – Heart Rate]	Heart Rate Service	[3] 2	-	-	Primary Service
HRS/SEN/SGGIT/CHA/BV-01-C [Characteristic GGIT – Heart Rate Measurement]	Heart Rate Measurement Characteristic	[3] 3.1	0x10 (Notify)	Skip	-
HRS/SEN/SGGIT/CHA/BV-02-C [Characteristic GGIT – Body Sensor Location]	Body Sensor Location Characteristic	[3] 3.2	0x02 (Read)	Skip	-
HRS/SEN/SGGIT/CHA/BV-03-C [Characteristic GGIT – Heart Rate Control Point]	Heart Rate Control Point Characteristic	[3] 3.3	0x08 (Write)	Skip	-

Table 4.2: Input for the GGIT Server test procedure

4.4 Characteristic Read

- Test Purpose

This test group contains test cases to read and verify that the characteristic values required by the service are compliant. The verification is done one value at the time, as enumerated in the test cases in [Table 4.3](#), using this generic test procedure.

- Reference

[\[3\]](#) 3.2.1

- Initial Condition

- The handle of each characteristic value referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in [Section 4.3](#) or is known to the Lower Tester by other means.
- If the IUT requires a bonding procedure then perform a bonding procedure.
- Establish an ATT Bearer connection between the Lower Tester and IUT as described in [Section 4.2.1](#).
- If IUT permissions for the characteristic require a specific security mode or security level, establish a connection meeting those requirements.

- Test Case Configuration

Test Case	Value Requirements
HRS/SEN/CR/BV-01-C [Characteristic Read - Body Sensor Location]	[3] 3.2.1

Table 4.3: Characteristic Read Value test cases

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.3](#):

1. The Lower Tester sends an ATT_Read_Request to the IUT to read the characteristic value.
2. The IUT sends an ATT_Read_Response to the Lower Tester.
3. Verify that the characteristic value meets the requirements of the service.
4. Repeat steps 1–3 for each instance of the characteristic.

- Expected Outcome

Pass verdict

The characteristic is successfully read and the characteristic value meets the requirements of the service.

4.5 Characteristic Write

This test group contains test cases to write and verify that the characteristic values required by the service are compliant.

HRS/SEN/CW/BV-01-C [Characteristic Write – Heart Rate Control Point – Reset Energy Expended]

- Test Purpose

Verify that the IUT responds appropriately when a Client writes the Heart Rate Control Point for Reset Energy Expended.
- Reference

[3] 3.3.1
- Initial Condition
 - If the IUT requires a bonding procedure then perform a bonding procedure.
 - The Heart Rate Measurement characteristic is configured for notification.
 - Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1.
 - If IUT permissions for the Heart Rate Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.
- Test Procedure
 1. Perform an action on the IUT that will induce it to send notifications of the Heart Rate Measurement characteristic along with Energy Expended values as in [HRS/SEN/CN/BV-02-C \[Heart Rate Measurement Notifications – Energy Expended\]](#).
 2. After receiving a characteristic with the Energy Expended field present, note the value of this field.
 3. Write the Heart Rate Control Point characteristic value of 0x01 (Reset Energy Expended) by using the Characteristic Value Write test procedure in [5].
 4. After receiving another characteristic with the Energy Expended field present, confirm that the value in this field has been reset.
- Expected Outcome

Pass verdict

The Energy Expended field in the Heart Rate Measurement characteristic is successfully reset.

HRS/SEN/CW/BI-01-C [Characteristic Write – Heart Rate Control Point – Unsupported Control Point]

- Test Purpose

Verify that the IUT responds appropriately when a Client writes an unsupported value into the Heart Rate Control Point.
- Reference

[3] 3.3.1

- Initial Condition
 - If the IUT requires a bonding procedure then perform a bonding procedure.
 - Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1.
 - If IUT permissions for the Heart Rate Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.
- Test Procedure
 1. Write to the Heart Rate Control Point characteristic a value from the Reserved for Future Use range by using the Characteristic Value Write test procedure in [5].
 2. Verify the proper response of the IUT.
- Expected Outcome

Pass verdict

The IUT responds with Control Point Not Supported (0x80).

4.6 Configure Notification

- Test Purpose

This test group contains test cases to verify compliant operation in response to enable and disable characteristic notification. The verification is done one value at the time, as enumerated in the test cases in Table 4.4, using this generic test procedure.
- Reference

[3] 3.1.2
- Initial Condition
 - The handle of each characteristic value referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in Section 4.3 or is known to the Lower Tester by other means.
 - The handle of the client characteristic configuration descriptor of each characteristic referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in Section 4.3 or is known to the Lower Tester by other means.
 - If the IUT requires a bonding procedure then perform a bonding procedure.
 - Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1.
 - If IUT permissions for the characteristic descriptor require a specific security mode or security level, establish a connection meeting those requirements.
- Test Case Configuration

Test Case	Requirements
HRS/SEN/CON/BV-01-C [Configure Notification - Heart Rate Measurement]	[3] 3.1.2.1

Table 4.4: Configure Notification test cases

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.4](#):

1. The Lower Tester sends an ATT_Write_Request to disable notification by writing value 0x0000 to the client characteristic configuration descriptor of the characteristic.
2. The Lower Tester sends an ATT_Write_Request to enable notification by writing value 0x0001 to the client characteristic configuration descriptor of the characteristic.
3. The Lower Tester reads the value of the client characteristic configuration descriptor.

- Expected Outcome

Pass verdict

The characteristic descriptor is successfully written and the value returned when read is consistent with the value written.

4.7 Characteristic Notification

HRS/SEN/CN/BV-01-C [Heart Rate Measurement Notifications]

- Test Purpose

Verify that the IUT can send notifications of the Heart Rate Measurement characteristic.

- Reference

[\[3\]](#) 3.1

- Initial Condition

- If the IUT requires a bonding procedure then perform a bonding procedure.
- The Heart Rate Measurement characteristic is configured for notification.
- Establish an ATT Bearer connection between the Lower Tester and IUT as described in [Section 4.2.1](#).
- If IUT permissions for the Heart Rate Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.

- Test Procedure

1. Perform an action on the IUT that will induce it to send notifications of the Heart Rate Measurement characteristic.
2. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
3. The Lower Tester receives an *ATT_Handle_Value_Notification* from the IUT containing the Heart Rate Measurement characteristic handle and value.
4. Verify that the characteristic value meets the requirements of the service.
5. Repeat steps 3-4 for each received notification until the IUT stops sending notifications.
6. The Lower Tester configures the Heart Rate Measurement characteristic to disable notifications.
7. Repeat steps 1-2 with notifications disabled.
8. Verify that the Lower Tester does not receive an *ATT_Handle_Value_Notification* from the IUT containing the Heart Rate Measurement characteristic.

- Expected Outcome

Pass verdict

The IUT sends one or more notifications of the Heart Rate Measurement characteristic with the appropriate flag set in the Flags field.

The value of the characteristic meets the requirements of the service.

The IUT stops sending notifications of the Heart Rate Measurement characteristic after the Lower Tester configures the characteristic to disable notifications.

HRS/SEN/CN/BV-02-C [Heart Rate Measurement Notifications – Energy Expended]

- Test Purpose

Verify that the IUT can send notifications of the Heart Rate Measurement characteristic that include Energy Expended values.

- Reference

[3] 3.1

- Initial Condition

- If the IUT requires a bonding procedure then perform a bonding procedure.
- The Heart Rate Measurement characteristic is configured for notification.
- Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1.
- If IUT permissions for the Heart Rate Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.

- Test Procedure

1. Perform an action on the IUT that will induce it to send notifications of the Heart Rate Measurement characteristic along with Energy Expended values.
2. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
3. The Lower Tester receives an *ATT_Handle_Value_Notification* from the IUT containing the Heart Rate Measurement characteristic handle and value.
4. Verify that the characteristic value meets the requirements of the service.

- Expected Outcome

Pass verdict

The IUT sends one or more notifications of the Heart Rate Measurement characteristic that include the Energy Expended value with the appropriate flag set in the Flags field.

The value of the characteristic meets the requirements of the service.

HRS/SEN/CN/BV-03-C [Heart Rate Measurement Notifications – RR-Interval]

- Test Purpose

Verify that the IUT can send notifications of the Heart Rate Measurement characteristic that include RR-Interval values.



- Reference
[3] 3.1
- Initial Condition
 - If the IUT requires a bonding procedure then perform a bonding procedure.
 - The Heart Rate Measurement characteristic is configured for notification.
 - Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1.
 - If IUT permissions for the Heart Rate Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.
- Test Procedure
 1. Perform an action on the IUT that will induce it to send notifications of the Heart Rate Measurement characteristic along with RR-Interval values.
 2. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
 3. The Lower Tester receives an *ATT_Handle_Value_Notification* from the IUT containing the Heart Rate Measurement characteristic handle and value.
 4. Verify that the characteristic value meets the requirements of the service.

- Expected Outcome

Pass verdict

The IUT sends one or more notifications of the Heart Rate Measurement characteristic that include one or more the RR-Interval values with the appropriate flag set in the Flags field.

The value of the characteristic meets the requirements of the service.

When more than one RR-Interval value is present in the characteristic, the values are arranged from oldest to newest as defined in the characteristic definition.

HRS/SEN/CN/BV-04-C [Heart Rate Measurement Notifications – 16-bit HR Value]

- Test Purpose

Verify that the IUT can send notifications of the Heart Rate Measurement characteristic that are 16 bits in length.
- Reference
[3] 3.1
- Initial Condition
 - If the IUT requires a bonding procedure then perform a bonding procedure.
 - The Heart Rate Measurement characteristic is configured for notification.
 - Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1.
 - If IUT permissions for the Heart Rate Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.

- Test Procedure
 1. Perform an action on the IUT that will induce it to send notifications of the Heart Rate Measurement characteristic along with 16-bit Heart Rate Measurement values.
 2. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
 3. The Lower Tester receives an *ATT_Handle_Value_Notification* from the IUT containing the Heart Rate Measurement characteristic handle and value.
 4. Verify that the characteristic value meets the requirements of the service.
- Expected Outcome

Pass verdict

The IUT sends one or more notifications of the Heart Rate Measurement characteristic that include one or more 16-bit Heart Rate Measurement Values with the appropriate flag set in the Flags field.

The value of the characteristic meets the requirements of the service.

HRS/SEN/CN/BV-05-C [Heart Rate Measurement Notifications – Sensor Contact]

- Test Purpose

Verify that the IUT can send notifications of the Heart Rate Measurement characteristic along with Sensor Contact feature information.
- Reference

[3] 3.1
- Initial Condition
 - If the IUT requires a bonding procedure then perform a bonding procedure.
 - The Heart Rate Measurement characteristic is configured for notification.
 - Establish an ATT Bearer connection between the Lower Tester and IUT as described in Section 4.2.1.
 - If IUT permissions for the Heart Rate Measurement characteristic require a specific security mode or security level, establish a connection meeting those requirements.
- Test Procedure
 1. Perform an action on the IUT that will induce it to send notifications of the Heart Rate Measurement characteristic along with Sensor Contact information in the Flags field.
 2. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
 3. The Lower Tester receives an *ATT_Handle_Value_Notification* from the IUT containing the Heart Rate Measurement characteristic handle and value.
 4. Perform an action on the IUT that will induce a change to the Sensor Contact bit (e.g. contact with sensor, no contact with sensor).
 5. Verify that the characteristic value meets the requirements of the service.
- Expected Outcome

Pass verdict

The IUT sends notifications of the Heart Rate Measurement characteristic that include Sensor Contact information in the Flags field.

Sensor Contact Support bit (bit 2 of the Flags field) is 1.

As contact is detected and not detected, the Sensor Contact bit in the Flags field toggles appropriately: when no contact is detected, bit 1 of the flags field is 0 and when contact is detected, bit 1 of the flags field is 1.

The value of the characteristic meets the requirements of the service.

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 Heart Rate Service (HRS) [4].

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.

For the purpose and structure of the ICS/IXIT, refer to [1].

Item	Feature	Test Case(s)
HRS 2/1	Heart Rate Service	HRS/SEN/SGGIT/SER/BV-01-C
HRS 2/2	Heart Rate Measurement Characteristic	HRS/SEN/SGGIT/CHA/BV-01-C HRS/SEN/CON/BV-01-C HRS/SEN/CN/BV-01-C
HRS 2/3	Support for Heart Rate Measurement Values in UINT16 format	HRS/SEN/CN/BV-04-C
HRS 2/4	Sensor Contact feature	HRS/SEN/CN/BV-05-C
HRS 2/5	Energy Expended feature	HRS/SEN/CN/BV-02-C
HRS 2/6	RR-Interval feature	HRS/SEN/CN/BV-03-C
HRS 2/7	Body Sensor Location Characteristic	HRS/SEN/SGGIT/CHA/BV-02-C HRS/SEN/CR/BV-01-C
HRS 2/8	Heart Rate Control Point Characteristic	HRS/SEN/SGGIT/CHA/BV-03-C HRS/SEN/CW/BI-01-C
HRS 2/9	Heart Rate Control Point Characteristic – Reset Energy Expended	HRS/SEN/CW/BV-01-C

Table 5.1: Test case mapping

6 Revision history and acknowledgments

Revision History

Publication Number	Revision Number	Date	Comments
0	1.0.0	2011-07-12	Adopted by Bluetooth SIG Board of Directors
	1.0.1r00	2016-05-20	Converted to new Test Case ID conventions as defined in TSTO v4.1.
	1.0.1r01	2016-06-01	Review by Miles Smith
	1.0.1r02	2016-06-02	Review by Alicia Courtney
1	1.0.1	2016-07-14	Prepared for TCRL 2016-1 publication.
	1.0.2r00	2016-08-18	TSE 7044: Bit 1 of the flags field changed from “0” to “1” for test case HRS/SEN/CN/BV-05-C.
2	1.0.2	2016-12-13	Approved by BTI. Prepared for TCRL 2016-2 publication.
	1.0.2 edition 2r00	2018-11-29	Editorial changes only. Template updated. Revision History and contributors moved to the end of the document.
	1.0.2 edition 2	2019-12-13	Updated copyright page and confidentiality markings to support new Documentation Marking Requirements, performed minor formatting updates, and accepted all tracked changes to prepare for edition 2 publication.
	p3r00–r03	2023-04-25 – 2023-05-23	<p>TSE 22821 (rating 2): Converted the following 5 test cases to GGIT: HRS/SEN/SD/BV-01-C, HRS/SEN/DEC/BV-01-C – -03-C, and HRS/SEN/DES/BV-01-C. The 4 new GGIT converted TCIDs are HRS/SEN/SGGIT/SER/BV-01-C and HRS/SEN/SGGIT/CHA/BV-01-C – -03-C. Updated the TCMT accordingly.</p> <p>Performed other editorials to align the document with the latest TS template, including updates to the scope, references, Test Strategy, test case identification conventions, conformance, Pass/Fail verdict conventions, and TCMT introductory text. Changed section titles for single test cases to Heading 8 or 9 per the TS template. Replaced the Bluetooth logo in the footer and updated the copyright page to align with v2 of the DNMD. Deleted draft revision history comments prior to p0. Revised the document numbering convention, setting the last release publication of 1.0.2 as p2.</p>
3	p3	2023-06-29	Approved by BTI on 2023-05-28. Prepared for TCRL 2023-1 publication.

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