Battery Service

*Bluetooth*® Test Specification

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- **Abstract**: This document defines test structures and procedures for conformance test of products implementing the Battery Service Specification.
### Revision History

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1 Scope

This Bluetooth document contains the Test Suite Structure (TSS) and Test Cases (TC) to test the Bluetooth Battery Service Specification.

The objective of this test specification is to provide a basis for interoperability tests for Bluetooth devices giving a high probability of air interface interoperability between different manufacturers’ Bluetooth devices.
2 References, Definitions, and Abbreviations

2.1 References
This Bluetooth document incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter.

[1] Bluetooth Test Strategy and Terminology Overview
[2] Bluetooth Core Specification, Version 4.0 or later
[3] Battery Service Specification v1.0
[4] ICS Proforma for Battery Service, BAS.ICS

2.2 Definitions
For the purpose of this Bluetooth document, the definitions from [1] and [2] apply.

2.3 Abbreviations
For the purpose of this Bluetooth document, the definitions from [1] and [2] apply.
3 Test Suite Structure (TSS)

3.1 Overview

The Battery Service requires the presence of GAP, SM and GATT. This is illustrated in Figure 3.1.

![Battery Service Test Model]

**Figure 3.1: Battery Service Test Model**

3.2 Test Strategy

The test objectives are to verify functionality of the Battery Service within a Bluetooth Host and enable interoperability between Bluetooth Hosts on different devices. The testing approach is to cover mandatory and optional requirements in the service specification and to match these to the support of the IUT as described in the ICS Proforma.

The test equipment shall provide an implementation of the Radio Controller and the parts of the Host needed to perform the test cases defined in the Battery Service Test Specification. 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, an MMI, or another interface supported by the IUT.

The Battery 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.
The test suite structure is a tree with the first level representing the protocol groups in section 3.3.

3.3 Test Groups
The following test groups have been defined.

3.3.1 Service Definition
Verify the service definition.

3.3.2 Characteristic Declaration
Verify the presence and contents of characteristic declarations.

3.3.3 Characteristic Descriptors
Verify the presence and contents of characteristic descriptors.

3.3.4 Characteristic Read
Verify characteristics which support reading can be read. Verify the format and value of characteristic values.

3.3.5 Configure Notification
Verify characteristics can be configured for notification.

3.3.6 Characteristic Notification
Verify characteristics which support notification can be notified.

3.3.7 SDP Record
Verify the SDP record for the service.
4 Test Cases

4.1 Introduction

4.1.1 Test Case Identification Conventions

Test cases shall be assigned unique identifiers per the conventions in [1]. The convention used here is <spec abbreviation>/<IUT role>/<class>/<xx>-<nn>-<y>.

Test group abbreviations for class, feature, function, sub-function or capability (as applicable to this test specification) are defined in Table 4.1.

<table>
<thead>
<tr>
<th>Identifier</th>
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<tr>
<td>BAS</td>
<td>Battery Service</td>
</tr>
<tr>
<td>SR</td>
<td>Server Role</td>
</tr>
<tr>
<td>SD</td>
<td>Service Definition</td>
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<td>DEC</td>
<td>Characteristic Declaration</td>
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<td>DES</td>
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<td>CN</td>
<td>Characteristic Notification</td>
</tr>
<tr>
<td>SDP</td>
<td>SDP Record</td>
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*Table 4.1: Battery Service TC Class Naming Convention*

4.1.2 Conformance

When conformance is claimed, all capabilities indicated as mandatory for this Specification shall be supported in the specified manner (process-mandatory). This also applies for all optional and conditional capabilities for which support is indicated. All mandatory capabilities, and optional and conditional capabilities for which support is indicated, are subject to verification as part of the Bluetooth certification program.

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 that is not excluded by the Specification, OR

• That capabilities enabled by the implementations are sustained over durations expected by the use case, OR

• That the implementation gracefully handles any quantity of data expected by the use case, OR
• That in cases where more than one valid interpretation of the Specification exist, the implementation complies with at least one interpretation and gracefully handles other interpretations OR

• That the implementation is immune to attempted security exploits.

A single execution of each of the required tests is required in order to constitute a pass verdict. However, it is noted that in order 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 Generator, the Test Case as described in the Test Specification, or with the Test System utilized, the Member is required to notify the responsible party via an errata request such that the issue may be addressed.

4.1.3 Pass/Fail Verdict Conventions

Each test case has an Expected Outcome section, which outlines all the detailed pass criteria conditions that shall be met by the IUT to merit a Pass Verdict.

The convention in this test specification is that, unless there are 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 and in case this occurs the outcome of the test shall be the Fail Verdict.

4.2 Setup Preambles

The procedures defined in this section are provided for information, as they are used by test equipment in achieving the initial conditions in certain tests.

4.2.1 ATT Bearer on BR/EDR Transport

Follow the preamble procedure described in [5] section 4.2.1.1.

4.2.2 ATT Bearer on LE Transport

Follow the preamble procedure described in [5] section 4.2.1.2.

4.2.3 Observation Procedure Passive Scanning

Follow the preamble procedure described in [6] section 5.7.1.1.1.

4.3 Service Definition

Verify the service definition.

4.3.1 BAS/SR/SD/BV-01-C [Service Definition]

• Test Purpose

  Verify that the IUT has one or more instantiations of the Battery Service as a primary service.
• Reference

[3] 2

• Initial Condition

Establish an ATT Bearer connection between the Lower Tester and IUT as described in section 4.2.1 or section 4.2.2.

• Test Procedure

For each supported transport:

1. Discover primary services by service UUID with the service UUID set to «Battery Service».
   a. For LE transport, execute the test procedure of GATT test case GATT/SR/GAD/BV-01-C, Discover All Primary Services, or GATT/SR/GAD/BV-02-C, Discover Primary Services by Service UUID in [5].
   b. For BR/EDR, execute the test procedure of GATT test case GATT/SR/GAD/BV-08-C in [5].

2. Verify one or more attribute handle ranges is returned, containing the starting handle and the ending handle of each service definition.

• Expected Outcome

Pass verdict

One or more attribute handle ranges is returned, containing the starting handle and the ending handle of each Battery Service definition.

4.4 Characteristic Declaration

This test group contains test cases to verify that the characteristic property field of the characteristic declaration meets the requirements of the service.

4.4.1 BAS/SR/DEC/BV-01-C [Characteristic Declaration – Battery Level]

• Test Purpose

Verify that the characteristic declaration of the Battery Level characteristic meets the requirements of the service.

• Reference

[3] Table 3-1

• Initial Condition
The handle range of each instance of the Battery Service has been previously discovered by the Lower Tester in test case BAS/SR/SD/BV-01-C [Service Definition].

Establish an ATT Bearer connection between the Lower Tester and IUT as described in section 4.2.1 or section 4.2.2.

- Test Procedure

For each supported transport the following test procedure applies:

1. Discover all characteristics of the Battery Service by executing the test procedure of GATT test case GATT/SR/GAD/BV-04-C, Discover All Characteristics of a Service, or GATT/SR/GAD/BV-05-C, Discover Characteristics by UUID in [5].

2. For a discovered Battery Level characteristic that, verify the characteristic properties field of the characteristic declaration meets the requirements of the service.

3. Repeat steps 1-2 for each instance of the service.

- Expected Outcome

Pass verdict

The Battery Level characteristic is discovered and the characteristic properties field of the characteristic declaration meets the requirements of the service.

4.5 Characteristic Descriptors

This test group contains test cases to verify that the characteristic descriptors meet the requirements of the service.

4.5.1 BAS/SR/DES/BV-01-C [Battery Level – Characteristic Presentation Format Descriptor]

- Test Purpose

Verify that the characteristic descriptor of the Battery Level characteristic, Characteristic Presentation Format meets the requirements of the service.

- Reference

[3] 3.1.2.1

- Initial Condition

The handle range of each Battery Level characteristic has been previously discovered by the Lower Tester during the test procedure in section 4.4 or is known to the Lower Tester by other means.

Establish an ATT Bearer connection between the Lower Tester and IUT as described in section 4.2.1 or section 4.2.2.
• Test Procedure

For each supported transport the following test procedure applies:

1. Discover all characteristic descriptors of the Battery Level characteristic by executing the test procedure of GATT test case GATT/SR/GAD/BV-06-C, Discover All Characteristic Descriptors in [5] using the handle range of the characteristic. The IUT returns one or more handle-UUID pairs.

2. If the UUID in a handle-UUID pair is for a Characteristic Presentation Format characteristic descriptor, read the characteristic descriptor by executing the test procedure of GATT test case GATT/SR/GAR/BV-06-C, Read Characteristic Descriptors in [5].

3. Verify the value of the characteristic descriptor meets the requirements of the service.

4. Repeat steps 2-3 for each handle-UUID pair.

5. Repeat steps 1-4 for each instance of the characteristic and service.

• Expected Outcome

*Pass verdict*

The Characteristic Presentation Format characteristic descriptor is discovered, the characteristic descriptor is read, and the value of the characteristic descriptor meets the requirements of the service.

4.5.2 BAS/SR/DES/BV-02-C [Battery Level – Client Characteristic Configuration Descriptor]

• Test Purpose

Verify that the characteristic descriptor of the Battery Level characteristic, Client Characteristic Configuration descriptor meets the requirements of the service.

• Reference

[3] 3.1.2.2

• Initial Condition

The handle range of each Battery Level characteristic has been previously discovered by the Lower Tester during the test procedure in section 4.4 or is known to the Lower Tester by other means.

Establish an ATT Bearer connection between the Lower Tester and IUT as described in section 4.2.1 or section 4.2.2.

• Test Procedure

For each supported transport the following test procedure applies:
1. Discover all characteristic descriptors of the Battery Level characteristic by executing the test procedure of GATT test case GATT/SR/GAD/BV-06-C, Discover All Characteristic Descriptors, in [5] using the handle range of the characteristic. The IUT returns one or more handle-UUID pairs.

2. If the UUID in a handle-UUID pair is for a Client Characteristic Configuration characteristic descriptor, read the characteristic descriptor by executing the test procedure of GATT test case GATT/SR/GAR/BV-06-C, Read Characteristic Descriptors in [5].

3. Verify the value of the characteristic descriptor meets the requirements of the service.

4. Repeat steps 2-3 for each handle-UUID pair.

5. Repeat steps 1-4 for each instance of the characteristic and service.

- Expected Outcome

Pass verdict
The Client Characteristic Configuration characteristic descriptor is discovered, the characteristic descriptor is read, and the value of the characteristic descriptor meets the requirements of the service.

### 4.6 Characteristic Read

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

#### 4.6.1 BAS/SR/CR/BV-01-C [Characteristic Read - Battery Level]

- **Test Purpose**

Verify that the characteristic value of the Battery Level characteristic can be read.

- **Reference**

[3] 3.1.1

- **Initial Condition**

The handle range of each Battery Level characteristic value has been previously discovered by the Lower Tester during the test procedure in section 4.4 or is known to the Lower Tester by other means.

Establish an ATT Bearer connection between the Lower Tester and IUT as described in section 4.2.1 or section 4.2.2.

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

- **Test Procedure**
For each supported transport the following test procedure applies:

1. Read the Battery Level characteristic value by executing the test procedure of GATT test case GATT/SR/GAR/BV-01-C, Read Characteristic Value, or GATT/SR/GAR/BV-03-C, Read Using Characteristic UUID, in [5].

2. Verify the characteristic value meets the requirements of the service.

3. Repeat steps 1-2 for each instance of the characteristic and service.

- Expected Outcome

Pass verdict
The Battery Level characteristic is successfully read and the characteristic value meets the requirements of the service.

4.7 Configure Notification
This test group contains test cases to verify compliant operation in response to enable and disable characteristic notification.

4.7.1 BAS/SR/CON/BV-01-C [Configure Notification - Battery Level]

- Test Purpose
Verify the IUT can be configured for notifications of characteristic values.

- Reference
[3] 3.1.2.2

- Initial Condition
The handle range of each Battery Level characteristic value has been previously discovered by the Lower Tester during the test procedure in section 4.4 or is known to the Lower Tester by other means.

The handle of the client characteristic configuration descriptor of the Battery Level characteristic has been previously discovered by the Lower Tester during the test procedure in section 4.5 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 or section 4.2.2.

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

- Test Procedure
For each supported transport the following test procedure applies:
1. Disable notification by writing value 0x0000 to the client characteristic configuration descriptor of the Battery Level characteristic using the test procedure of GATT test case GATT/SR/GAW/BV-08-C in [5].

2. Enable notification by writing value 0x0001 to the client characteristic configuration descriptor of the characteristic.

3. Repeat steps 1 and 2 for each instance of the characteristic and service.

   - Expected Outcome

   **Pass verdict**
   
   The Client Characteristic Configuration characteristic descriptor is successfully written and the value returned when read is consistent with the value written.

### 4.8 Characteristic Notification

This test group contains test cases to verify compliant operation when the IUT sends notifications of characteristic values.

#### 4.8.1 BAS/SR/CN/BV-01-C [Characteristic Notification - Battery Level]

- **Test Purpose**

  Verify the IUT sends notifications of characteristic values.

- **Reference**

  [3] 3.1.1

- **Initial Condition**

  The handle range of each Battery Level characteristic value has been previously discovered by the Lower Tester during the test procedure in section 4.4 or is known to the Lower Tester by other means.

  The characteristic is configured for notification.

  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 or section 4.2.2.

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

- **Test Procedure**

  For each supported transport the following test procedure applies:

  1. Perform an action on the IUT that will induce it to send a notification of the Battery Level characteristic.
2. The Lower Tester receives an ATT_Handle_Value_Notification from the IUT containing the characteristic handle and value.

3. Verify the characteristic value meets the requirements of the service.
   • Expected Outcome

   **Pass verdict**
   The Battery Level characteristic is successfully notified and the characteristic value meets the requirements of the Battery Service.

### 4.9 Service Discovery

This test group contains test cases to verify the SDP record.

#### 4.9.1 BAS/SR/SDP/BV-01-C [SDP Record]

• Test Purpose

   Verify the IUT SDP record for the Battery Service.

• Reference

   [3] 5

• Initial Condition

   An ACL connection over BR/EDR is established between the Lower Tester and IUT.

• Test Procedure

   1. The Lower Tester establishes an SDP connection to the IUT.
   2. The Lower Tester sends SDP requests to retrieve all attributes of the SDP record for the Battery service.

• Expected Outcome

   **Pass verdict**
   The SDP record for the Battery service is found.
   All attributes which are mandatory for the Battery service are present in the SDP record.
   The values of all attributes in the SDP record meet the requirements of the Battery service.
   The GATT Start Handle and GATT End Handle parameters in the SDP record match the start handle and end handle of the Battery service.
5 Test Case Mapping

The Test Case Mapping Table (TCMT) maps test cases to specific capabilities in the ICS.

The columns for the TCMT are defined as follows:

- **Item**: contains an y/x reference, where y corresponds to the table number and x corresponds to the feature number as defined in the ICS Proforma for Battery Service (BAS) [4]. If the item is defined with Protocol, Profile or Service abbreviation before y/x, the table and feature number referenced are defined in the abbreviated ICS proforma document.

- **Feature**: recommended to be the primary feature defined in the ICS being tested or may be the test case name.

- **Test Case(s)**: the applicable test case identifiers required for Bluetooth Qualification if the corresponding y/x references defined in the Item column are supported.

- **Test Case Applicable**: may be used to note if a test is required based on the supported features.

For purpose and structure of the ICS/IXIT proforma and instructions for completing the ICS/IXIT proforma refer to the Bluetooth ICS and IXIT proforma document.

<table>
<thead>
<tr>
<th>Item</th>
<th>Feature</th>
<th>Test Case(s)</th>
<th>Test Case Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS 2/1</td>
<td>Battery Service</td>
<td>BAS/SR/SD/BV-01-C</td>
<td></td>
</tr>
<tr>
<td>BAS 2/3</td>
<td>Battery Level Characteristic</td>
<td>BAS/SR/DEC/BV-01-C</td>
<td>BAS/SR/CR/BV-01-C</td>
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<tr>
<td>BAS 2/4</td>
<td>Battery Level Characteristic Presentation Format</td>
<td>BAS/SR/DES/BV-01-C</td>
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<td></td>
<td>Descriptor</td>
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<tr>
<td>BAS 2/5</td>
<td>Battery Level Client Characteristic Configuration</td>
<td>BAS/SR/DES/BV-02-C</td>
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<td>Descriptor</td>
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<tr>
<td>BAS 2a/1</td>
<td>Battery Level Characteristic - Notifications</td>
<td>BAS/SR/CON/BV-01-C</td>
<td>BAS/SR/CN/BV-01-C</td>
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<tr>
<td>BAS 2/6</td>
<td>SDP interoperability</td>
<td>BAS/SR/SDP/BV-01-C</td>
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</tbody>
</table>

*Table 5.1: Test Case Mapping*