Volume Offset Control Service (VOCS)

***Bluetooth*® Test Suite**

- **Revision:** VOCS.TS.p1
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- **Group Prepared By:** Generic Audio Working Group

Contents

1 Scope

This Bluetooth document contains the Test Suite Structure (TSS) and test cases (TC) to test the implementation of the Bluetooth Volume Offset Control Service 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 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 hereinafter.

[1] Bluetooth Core Specification, Version 4.2 or later

[2] Test Strategy and Terminology Overview

[3] Volume Offset Control Service, Version 1.0

[4] Volume Offset Control Service ICS, VOCS.ICS

[5] GATT Test Suite, GATT.TS

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

[7] Volume Offset Control Service IXIT Proforma

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 from [1] and [2] apply.

3 Test Suite Structure (TSS)

3.1 Overview

The Volume Offset Control Service requires the presence of GAP, SM (when used over LE transport), SDP (when used over BR/EDR transport), L2CAP, and GATT. EATT can optionally be used. This is illustrated in Figure 3.1.

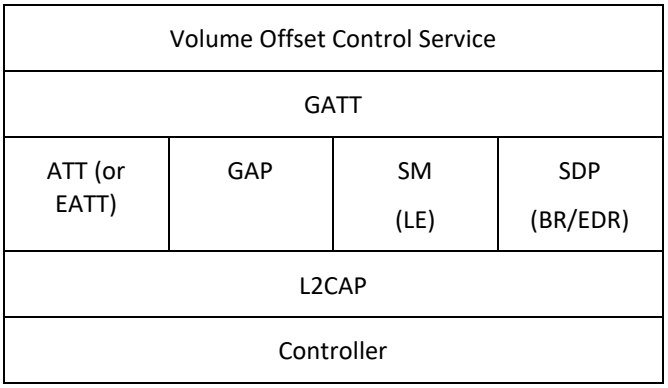

Figure 3.1: Volume Offset Control Service Test Model

3.2 Test Strategy

The test objectives are to verify functionality of the Volume Offset Control Service within a Bluetooth Host and to enable interoperability between Bluetooth Hosts on different devices, specifically between a VOCS server and a GATT enabled client. The testing approach covers mandatory and optional requirements in the service specification and matches these to the support of the IUT as described in the ICS. Any defined test in here is applicable to the IUT, if the ICS logical expression defined in the Test Case Mapping Table (TCMT) is valid.

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 Volume Offset Control Service Test Suite. 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 Volume Offset Control Service Test Suite contains Valid Behavior (BV) tests complemented with Invalid Behavior (BI) tests where required. Additionally, since Volume Offset Control Service is a GATT Server based service, the Generic GATT Integrated Tests (GGIT) are used to validate parts of the specification.

3.3 Test groups

The following test groups have been defined:

- Generic GATT Integrated Tests

  Verify the generic GATT behavior for discovery, characteristics, descriptors, indications, notifications, etc.

- Volume Offset Control Point Procedures

  Verify the behavior of a procedure triggered by writing Opcodes to the Volume Offset Control Point.

- Service Procedure – Error Handling

  Verify that the IUT correctly handles error conditions that result from the characteristic writes or failure to perform a requested operation due to rejection of the request by a Remote Device.

- Service Procedure – Notification

  Verify that the IUT correctly handles updates of the characteristic and properly sends a Notification.

4 Test cases (TC)

4.1 Introduction

4.1.1 Test case identification conventions

Test cases shall be 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 a set of 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>**
VOCS	Volume Offset Control Service
Identifier Abbreviation	**Role Identifier <IUT role>**
SR	Server
Identifier Abbreviation	**Feature Identifier <feat>**
CP	Control Point
SGGIT	Server Generic GATT Integrated Tests
SPE	Service Procedure – Error Handling
SPN	Service Procedure – Notifications

Table 4.1: VOCS TC feature naming convention

4.1.2 Conformance

When conformance is claimed for a particular specification, all capabilities are to be supported in the specified manner (process-mandatory). 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 that is 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 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 generated by Launch Studio, 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 errata 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, the outcome of the test is a Fail verdict.

4.2 Setup preambles

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

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 channel (PSM 0x001F) between the IUT and the Lower Tester over that BR/EDR transport.

4.2.3 EATT Bearer on LE Transport

Preamble procedure:

1. Establish an LE transport connection between the IUT and the Lower Tester.
2. Establish an L2CAP channel 0x0005 for signaling and one L2CAP channel (for ATT bearers) with EATT PSM (as defined in Assigned Numbers) between the IUT and the Lower Tester over that LE transport.

4.2.4 EATT 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 channel 0x0001 for signaling and one L2CAP channel (for ATT bearers) with EATT PSM (as defined in Assigned Numbers) between the IUT and the Lower Tester over that BR/EDR transport.

4.2.5 Volume Offset Control Point

Preamble procedure:

1. Establish an ATT Bearer connection between the Lower Tester and the IUT as described in Section 4.2.1, if using ATT over an LE transport, or 4.2.2 if using ATT over a BR/EDR transport, or 4.2.3 if using EATT over an LE transport, or 4.2.4 if using EATT over a BR/EDR transport.
2. The handle of the Volume Offset Control Point characteristic has been previously discovered by the Lower Tester during a test procedure in Section 4.3 or is known to the Lower Tester by other means.
3. The handle of the Client Configuration Descriptor of the Volume Offset Control Point characteristic has been previously discovered by the Lower Tester during a test procedure in Section 4.4 or is known to the Lower Tester by other means.
4. If the IUT requires bonding, then the Lower Tester performs a bonding procedure.
5. Enable notification by writing the value 0x0001 using the GATT Write Characteristic Descriptor sub-procedure for the Volume Offset State CCCD.

4.3 Generic GATT Integration Tests

Execute the Generic GATT Integrated Tests defined in Section 6.3 in [5] Server Test Procedures using Table 4.2 below as input:

Test Cases	Service / Characteristic / Descriptor	Reference	Properties	Value Length (Octets)
VOCS/SR/SGGIT/SER/BV-01-C [Service GGIT – Volume Offset]	Volume Offset Control Service	[3] 3.1	-	-
VOCS/SR/SGGIT/SDP/BV-01-C [SDP GGIT – Volume Offset Control Service]	Volume Offset Control Service	[3] 4	-	-
VOCS/SR/SGGIT/CHA/BV-01-C [Characteristic GGIT –Volume Offset State]	Volume Offset State Characteristic	[3] 3.1	0x12 (Read, Notify)	3
VOCS/SR/SGGIT/CHA/BV-02-C [Characteristic GGIT – Audio Location]	Audio Location Characteristic	[3] 3.2	Mandatory: 0x02 (Read) Optional: 0x10 (Notify) 0x04 (WriteWithoutResponse)	4
VOCS/SR/SGGIT/CHA/BV-03-C [Characteristic GGIT – Volume Offset Control Point]	Volume Offset Control Point Characteristic	[3] 3.3	0x08 (Write)	Skip
VOCS/SR/SGGIT/CHA/BV-04-C [Characteristic GGIT – Audio Output Description]	Audio Output Description Characteristic	[3] 3.4	Mandatory: 0x02 (Read) Optional: 0x10 (Notify) 0x04 (WriteWithoutResponse)	Skip

Table 4.2: Input for the GGIT Server test procedure

4.4 Control Point Procedures

Test group to test Volume Offset Control Point procedures.

VOCS/SR/CP/BV-01-C [Set Volume Offset]

- Test Purpose

  Verify that a VOCS Server IUT responds to writing the Set Volume Offset Opcode and updates its Volume Offset State characteristic.

- Reference

  [3] 3.3.2.1

- Initial Condition

  - Enable the IUT for use with the Volume Offset Control Point by performing the preamble described in Section 4.2.5.
  - Enable notification by writing the value 0x0001 using the GATT Write Characteristic Descriptor sub-procedure for the Volume Offset State CCCD.
  - The Upper Tester sets the Change_Counter field of the Volume Offset State characteristic to 254 if the IUT supports the setting of the Change_Counter.

- Test Procedure

  1. The Lower Tester executes the GATT Read Characteristic Value sub-procedure for the Volume Offset State characteristic.

  Repeat steps 2–4 for (255 – Change_Counter value) + 1 times.

  2. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the Volume Offset Control Point characteristic with the Set Volume Offset Opcode, with the Volume Offset parameters set to a random value different from the last one, and the Change_Counter parameter.
  3. The Lower Tester receives a Write Response indicating that the IUT has accepted the Opcode.
  4. The Lower Tester receives a GATT Characteristic Value Notification for the Volume Offset State characteristic.

- Expected Outcome

  Pass verdict

  The IUT sends one notification of the Volume Offset State characteristic with the Volume Offset changed.

  The Volume Offset value is set to the value written by the Lower Tester.

  The Change_Counter value is incremented.

  The Change_Counter parameter rolls over to zero.

4.5 Service Procedure – Notifications

4.5.1 Update Characteristics

- Test Purpose

  This test group contains one or more test cases to verify the behavior of the IUT when it updates its characteristics while a Client is connected.

- Reference

  [3] 3.2, 3.4

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and the IUT as described in Section 4.2.1, if using ATT over an LE transport, or 4.2.2 if using ATT over a BR/EDR transport, or 4.2.3 if using EATT over an LE transport, or 4.2.4 if using EATT over a BR/EDR transport.
  - The Lower Tester has cached the VOCS service and characteristics handles (e.g., by running the procedures in Section 4.3).
  - The Lower Tester enables notification for the Audio Input Description characteristic by writing the value 0x0001 to the Audio Input Description CCCD using the GATT Write Characteristic Descriptor sub-procedure.

- Test Configuration

TCID	Characteristic	Step
VOCS/SR/SPN/BV-01-C [Update Audio Location Characteristic]	Audio Location	The Lower Tester executes the GATT Write Without Response Characteristic Value sub-procedure with a different value than received in step 1.
VOCS/SR/SPN/BV-02-C [Autonomously Update Audio Location Characteristic]	Audio Location	The Upper Tester orders the IUT to change the value of the Audio Location characteristic that is different than that received in step 1.
VOCS/SR/SPN/BV-03-C [Update Audio Output Description Characteristic]	Audio Output Description	The Lower Tester executes the GATT Write Without Response Characteristic Value sub-procedure with a different value than received in step 1.
VOCS/SR/SPN/BV-04-C [Autonomously Update Audio Output Description Characteristic]	Audio Output Description	The Upper Tester orders the IUT to change the value of the Audio Output Description characteristic that is different than that received in step 1.

Table 4.3 Update Characteristics test cases

- Test Procedure

  1. The Lower Tester reads the characteristic value for the characteristic specified in Table 4.3 by executing the GATT Read Characteristic Value sub-procedure.
  2. The Lower Tester executes the step specified in Table 4.3.
  3. The IUT sends a notification containing the updated value of the characteristic specified in Table 4.3.

- Expected Outcome

  Pass verdict

  In step 3, the characteristic value is correctly formatted and is different from the one received in step 1.

4.6 Service Procedure Error Handling

Test Cases	Control Point Characteristic	Reference	TC Configuration	Parameter(s)	Pass Verdict
VOCS/SR/SGGIT/CP/BI-01-C [Invalid Change Counter]	Volume Offset Control Point Characteristic	[3] 3.3.2		Opcode = Set Volume Offset Change_Counter = different than current one	Invalid Change Counter (0x80)
VOCS/SR/SGGIT/CP/BI-02-C [Op Code Not Supported]	Volume Offset Control Point Characteristic	[3] 1.6		Opcode = 0x02 (RFU)	Opcode Not Supported (0x81)
VOCS/SR/SGGIT/CP/BI-03-C [Value Out of Range]	Volume Offset Control Point Characteristic	[3] 3.3.2.1	The Lower Tester knows the current Change_Counter or executes the GATT Read Characteristic Value sub-procedure for the Volume Offset State characteristic. Test procedure run in rounds. 1: Volume_Offset parameters set to a random value greater than 255 2: Volume_Offset parameters set to a random value less than -255	Opcode = Set Volume Offset Change_Counter = current Change Counter value	Value Out of Range (0x81)

Table 4.4 Service Procedure Error Handling Generic test cases

VOCS/SR/SPE/BI-01-C [Ignore Invalid Audio Locations]

- Test Purpose

  Verify that the IUT ignores the setting of RFU values for the Audio Location characteristic.

- Reference

  [3] 3.2

- Initial Condition

  - A bearer connection is established between the Lower Tester and the IUT as described in Section 4.2.1, if using an ATT over an LE transport, or 4.2.2 if using an ATT over a BR/EDR transport, or 4.2.3 if using EATT over an LE transport, or 4.2.4 if using EATT over a BR/EDR transport.
  - The Lower Tester has cached the VOCS service and characteristics handles (e.g., by running the procedures in Section 4.3).
  - If the IUT requires bonding, then the Lower Tester performs a bonding procedure.

- Test Procedure

  1. The Lower Tester executes the GATT Read Characteristic Value sub-procedure for the Audio Location Characteristic.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure for the Audio Location with a different value with RFU bits set.
  3. The Lower Tester executes the GATT Read Characteristic Value sub-procedure for the Audio Location Characteristic.

- Expected Outcome

  Pass verdict

  The IUT has the proper value set in step 3.

5 Test case mapping

The Test Case Mapping Table (TCMT) maps test cases to specific requirements in the ICS. The IUT will be 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 Volume Offset Control Service [4].

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

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.

For the purpose and structure of the ICS/IXIT and instructions for completing the ICS/IXIT, refer to the Bluetooth ICS and IXIT Proforma documents.

Item	Feature	Test Case(s)
VOCS 1/1	SDP Record	VOCS/SR/SGGIT/SDP/BV-01-C
VOCS 1/1 OR VOCS 1/2	Volume Offset Control Service	VOCS/SR/SGGIT/SER/BV-01-C
VOCS 2/1	Volume Offset State Characteristic	VOCS/SR/SGGIT/CHA/BV-01-C
VOCS 2/2	Audio Location Characteristic	VOCS/SR/SGGIT/CHA/BV-02-C VOCS/SR/SPE/BI-01-C
VOCS 2/3	Volume Offset Control Point Characteristic	VOCS/SR/SGGIT/CHA/BV-03-C VOCS/SR/CP/BV-01-C VOCS/SR/SGGIT/CP/BI-01-C VOCS/SR/SGGIT/CP/BI-02-C VOCS/SR/SGGIT/CP/BI-03-C
VOCS 2/4	Audio Output Characteristic	VOCS/SR/SGGIT/CHA/BV-04-C
VOCS 2/5 AND VOCS 2/6	Writable and Notifiable Audio Location Characteristic	VOCS/SR/SPN/BV-01-C
VOCS 2/6	Autonomous Audio Location Characteristic Update	VOCS/SR/SPN/BV-02-C
VOCS 2/7 AND VOCS 2/8	Writable and Notifiable Audio Output Description Characteristic	VOCS/SR/SPN/BV-03-C
VOCS 2/8	Autonomous Audio Output Description Characteristic Update	VOCS/SR/SPN/BV-04-C

Table 5.1: Test case mapping

6 Revision history and acknowledgments

Revision History

Publication Number	Revision Number	Date	Comments
	d09r00–r10	2019-05-15 – 2019-12-12	Sync with VolumeOffsetControlService_d09r03. Changes for IOP Test Plan. Sync with VolumeOffsetControlService_d09r05 and Seoul IOP Feedback. Sync with VolumeOffsetControlService_d09r06. Sync with VolumeOffsetControlService_d09r09. Changes for E12554, E12625. Changes for E12943 to correct VCS -> VOCS. Update the EATT preambles to match the Media Control version. Address BTI comments to test template raised against Media Control. Remove the heading numbers in the Test Case Configuration Table TCIDs.
	p0r00–r05	2019-12-15 – 2020-10-16	Add an IXIT value in the Audio Output Description GGIT test. Update some control point tests to use GGIT control point template. Format tables using the new BTI proposed format. Remove heading numbers in all headings with TCIDs. Integrate E13392. Integrate E14829, E14836, Test Issue 15702.
0	p0	2020-12-22	Approved by BTI on 2020-11-29. VOCS v1.0 adopted by the BoD on 2020-12-15. Prepared for publication.
	p1r00	2021-08-12	TSE 17306 (rating 2): Corrected TCMT entries for TCs VOCS/SR/SGGIT/SDP/BV-01-C and VOCS/SR/SGGIT/SER/BV-01-C. Performed template-related fixes. Updated copyright page to align with v2 of the DNMD.
1	p1	2022-01-25	Approved by BTI on 2021-12-15. Prepared for TCRL 2021-2 publication.

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