# Constant Tone Extension Service (CTES)

***Bluetooth*® Test Suite**

- **Revision:** CTES.TS.p1
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- **Group Prepared By:** DFWG

# Contents

# 1 Scope

This Bluetooth document contains the Test Suite Structure (TSS) and test cases (TC) to test the implementation of the Constant Tone Extension 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 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 Core Specification, Version 5.1 or later

[2] Test Strategy and Terminology Overview

[3] Constant Tone Extension Service Specification, Version 1.0

[4] ICS Proforma for Constant Tone Extension Service, CTES.ICS

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

[6] Constant Tone Extension Service Implementation eXtra Information for Test, IXIT

[7] GATT Test Suite, GATT.TS

## 2.2 Definitions

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

## 2.3 Abbreviations

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

# 3 Test Suite Structure (TSS)

## 3.1 Overview

The Constant Tone Extension Service requires the presence of GAP, SM, and GATT over ATT (with optional use of EATT). This is illustrated in Figure 3.1.

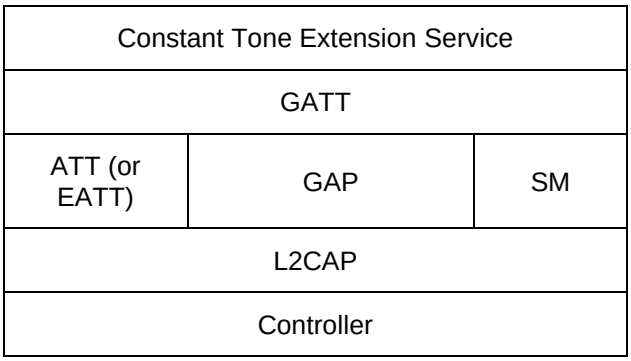


*Figure 3.1: Constant Tone Extension Service test model*

## 3.2 Test Strategy

The test objectives are to verify functionality of the Constant Tone Extension 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 Constant Tone Extension 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 Constant Tone Extension Service 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 as defined in Section 3.3.

## 3.3 Test Groups

The following test groups have been defined.

### 3.3.1 Generic GATT Integrated Tests

Verify that the IUT properly implements the GATT Server role for the supported service and characteristics.

### 3.3.2 Service Procedures

Verify the operation of additional procedures defined in the service specification. RFU bits are also tested for future-proofing the specification.

# 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 tests from the GATT Test Suite [7], referred to as Generic GATT Integrated Tests (GGIT); when used, the GGIT tests are referred through a TCID string using the following convention:
**<spec abbreviation>/<IUT role>/<GGIT test group>**/< GGIT class >/<xx>-<nn>-<y>.

| **Identifier Abbreviation** | **Specification Identifier <spec abbreviation>** |
|---|---|
| CTES | Constant Tone Extension Service |
| **Identifier Abbreviation** | **Role Identifier <IUT role>** |
| SR | Server Role |
| **Identifier Abbreviation** | **Class Identifier <class>** |
| SP | Service Procedures |

*Table 4.1: Constant Tone Extension Service TC identifier 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 for 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.

## 4.3 Generic GATT Integrated Tests

Execute the Generic GATT Integrated Tests defined in GATT.TS [7] Section 6.2, Server Test Procedures, using Table 4.2 below as input.

| Test Case | Service / Characteristic / Descriptor | Reference | Properties | Value Length (Octets) |
|---|---|---|---|---|
| CTES/SR/SGGIT/SER/BV-01-C [Service GGIT – Constant Tone Extension] | Constant Tone Extension Service | [3] 2.1 | - | - |
| CTES/SR/SGGIT/CHA/BV-01-C [Characteristic GGIT – Constant Tone Extension Enable] | Constant Tone Extension Enable Characteristic | [3] 3.1 | 0x08 (Write) | 1 |
| CTES/SR/SGGIT/CHA/BV-02-C [Characteristic GGIT – Advertising Constant Tone Extension Minimum Length] | Advertising Constant Tone Extension Minimum Length Characteristic | [3] 3.2 | 0x08 (Write) | 1 |
| CTES/SR/SGGIT/CHA/BV-03-C [Characteristic GGIT – Advertising Constant Tone Extension Minimum Transmit Count] | Advertising Constant Tone Extension Minimum Transmit Count Characteristic | [3] 3.3 | 0x08 (Write) | 1 |
| CTES/SR/SGGIT/CHA/BV-04-C [Characteristic GGIT – Advertising Constant Tone Extension Transmit Duration] | Advertising Constant Tone Extension Transmit Duration Characteristic | [3] 3.4 | 0x08 (Write) | 1 |
| CTES/SR/SGGIT/CHA/BV-05-C [Characteristic GGIT – Advertising Constant Tone Extension Interval] | Advertising Constant Tone Extension Interval Characteristic | [3] 3.5 | 0x08 (Write) | 2 |
| CTES/SR/SGGIT/CHA/BV-06-C [Characteristic GGIT – Advertising Constant Tone Extension PHY] | Advertising Constant Tone Extension PHY Characteristic | [3] 3.6 | 0x08 (Write) | 1 |

*Table 4.2: Input for the GGIT Server test procedure*

## 4.4 Service Procedures

### CTES/SR/SP/BV-01-C [Writing Constant Tone Extension Enable Behavior, Advertising with AoD Constant Tone Extension]

- Test Purpose

  Verify that the IUT enables or disables advertising with AoD Constant Tone Extension when the Constant Tone Extension Enable characteristic is written.

- Reference

  [3] 3.1.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Constant Tone Extension Enable characteristic has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to the value 0x00 (All Disabled).
  - The Lower Tester is configured to scan for advertising packets from the IUT throughout the test.
  - The IUT is configured to transmit advertising packets.

- Test Procedure

  1. The Lower Tester writes value 0x02 (Enable AoD Constant Tone Extension in advertising packets) to the Constant Tone Extension Enable characteristic.
  2. The IUT sends advertising packets with AoD Constant Tone Extension.
  3. The Lower Tester writes value 0x00 (All Disabled) to the Constant Tone Extension Enable characteristic.
  4. The IUT sends advertising packets without AoD Constant Tone Extension.

- Expected Outcome

  Pass verdict

  The IUT transmits advertising packets with AoD Constant Tone Extension when enabled and switches to transmitting advertising packets without AoD Constant Tone Extension when disabled.

### CTES/SR/SP/BV-02-C [Writing Constant Tone Extension Enable Behavior, Advertising with AoD Constant Tone Extension Not Supported]

- Test Purpose

  Verify that the IUT rejects a write to the Constant Tone Extension Enable characteristic with AoD Constant Tone Extension on Advertising set to enabled when AoD Constant Tone Extension on Advertising is not supported.

- Reference

  [3] 3.1.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Constant Tone Extension Enable characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x00 (All Disabled).

- Test Procedure

  1. The Lower Tester writes value 0x02 (Enable AoD Constant Tone Extension in advertising packets) to the Constant Tone Extension Enable characteristic and receives an Error Response with the Error Code set to 0xFC (Write Request Rejected).

- Expected Outcome

  Pass verdict

  The IUT rejects the write using an Error Response with the Error Code set to 0xFC (Write Request Rejected).

### CTES/SR/SP/BV-03-C [Writing Constant Tone Extension Enable Behavior, AoA Connection Constant Tone Extension Response]

- Test Purpose

  Verify that the IUT enables or disables AoA Connection Constant Tone Extension Responses when the Constant Tone Extension Enable characteristic is written.

- Reference

  [3] 3.1.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Constant Tone Extension Enable characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x00 (All Disabled).

- Test Procedure

  1. The Lower Tester writes value 0x01 (Enable AoA Constant Tone Extension on the ACL connection with the Client) to the Constant Tone Extension Enable characteristic.
  2. The Lower Tester transmits a Link Layer request for AoA Constant Tone Extension to the IUT.
  3. The Lower Tester receives a Link Layer response packet from the IUT with AoA Constant Tone Extension.
  4. The Lower Tester writes value 0x00 (All Disabled) to the Constant Tone Extension Enable characteristic.
  5. The Lower Tester transmits a Link Layer request for AoA Constant Tone Extension to the IUT.
  6. The Lower Tester receives a Link Layer response packet from the IUT with a rejection PDU with the error code set to Unsupported LMP Parameter Value/Unsupported LL Parameter Value.

- Expected Outcome

  Pass verdict

  When AoA Constant Tone Extension on the ACL connection is enabled, the IUT responds to an AoA Constant Tone Extension Request with a response packet containing an AoA Constant Tone Extension.

  When AoA Constant Tone Extension on the ACL connection is disabled, the IUT responds to an AoA Constant Tone Extension Request with a response packet rejecting the request with the error code set to Unsupported LMP Parameter Value/Unsupported LL Parameter Value.

### CTES/SR/SP/BV-04-C [Writing Constant Tone Extension Enable Behavior, AoA Connection Constant Tone Extension Response Not Supported]

- Test Purpose

  Verify that the IUT rejects a write to the Constant Tone Extension Enable characteristic with AoA Connection Constant Tone Extension Response set to be enabled when AoA Connection Constant Tone Extension Response is not supported.

- Reference

  [3] 3.1.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Constant Tone Extension Enable characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x00 (All Disabled).

- Test Procedure

  1. The Lower Tester writes value 0x01 (Enable AoA Constant Tone Extension on the ACL connection with the Client) to the Constant Tone Extension Enable characteristic and receives an Error Response with the Error Code set to 0xFC (Write Request Rejected).
  2. The Lower Tester terminates the ATT Bearer connection.

- Expected Outcome

  Pass verdict

  The IUT rejects the write using an Error Response with the Error Code set to 0xFC (Write Request Rejected).

### CTES/SR/SP/BV-05-C [Writing Advertising Constant Tone Extension Minimum Length Behavior]

- Test Purpose

  Verify that the IUT advertises with Constant Tone Extensions of the length specified by the Advertising Constant Tone Extension Minimum Length characteristic when enabled.

- Reference

  [3] 3.2.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Advertising Constant Tone Extension Minimum Length characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x02 (Enable AoD Constant Tone Extension in advertising packets).
  - The Lower Tester is configured to scan for advertising packets from the IUT throughout the test.
  - The IUT is configured to transmit advertising packets.

- Test Procedure

  1. The Lower Tester writes the minimum supported value for the Advertising Constant Tone Extension Minimum Length characteristic as defined in IXIT [6] to the Advertising Constant Tone Extension Minimum Length characteristic.
  2. The Lower Tester terminates the ATT Bearer connection.
  3. The Lower Tester receives advertising packets from the IUT with Constant Tone Extension of a length between the length set in step 1 and the maximum supported value for the Advertising Constant Tone Extension Minimum Length characteristic as defined in IXIT [6].
  4. If the IUT supports a maximum Advertising Constant Tone Extension Minimum Length different than the supported minimum length, repeat steps 1–3 except that the Lower Tester writes the maximum supported length defined in IXIT [6] in step 1.

- Expected Outcome

  Pass verdict

  The IUT transmits advertising packets with Constant Tone Extension of the written length.

### CTES/SR/SP/BV-06-C [Writing Advertising Constant Tone Extension Minimum Length Behavior, Out of Range]

- Test Purpose

  Verify that the IUT rejects a write to the Advertising Constant Tone Extension Minimum Length characteristic when the value is outside of the supported range.

- Reference

  [3] 3.2.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Advertising Constant Tone Extension Minimum Length characteristic 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 writes a value greater than the maximum supported Advertising Constant Tone Extension Minimum Length as defined in IXIT [6] to the Advertising Constant Tone Extension Minimum Length characteristic and receives an Error Response with the Error Code set to 0xFF (Out of Range).
  2. The Lower Tester writes a value lower than the minimum supported Advertising Constant Tone Extension Minimum Length as defined in IXIT [6] to the Advertising Constant Tone Extension Minimum Length characteristic and receives an Error Response with the Error Code set to 0xFF (Out of Range).

- Expected Outcome

  Pass verdict

  The IUT rejects the write using an Error Response with the Error Code set to 0xFF (Out of Range).

### CTES/SR/SP/BV-07-C [Writing Advertising Constant Tone Extension Transmit Duration Behavior]

- Test Purpose

  Verify that the IUT advertises with Constant Tone Extensions for the duration specified by the Advertising Constant Tone Extension Transmit Duration characteristic when enabled.

- Reference

  [3] 3.4.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Advertising Constant Tone Extension Transmit Duration characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x02 (Enable AoD Constant Tone Extension in advertising packets).
  - The Lower Tester is configured to scan for advertising packets from the IUT throughout the test.
  - The IUT is configured to transmit advertising packets with the minimum advertising interval.

- Test Procedure

  1. The Lower Tester writes the minimum supported non-zero Advertising Constant Tone Extension Transmit Duration as defined in IXIT [6] to the Advertising Constant Tone Extension Transmit Duration characteristic.
  2. The Lower Tester terminates the ATT Bearer connection.
  3. The Lower Tester receives advertising packets from the IUT with Constant Tone Extension for the transmit duration specified in step 1 and receives advertising packets without Constant Tone Extension afterwards.
  4. If the IUT supports a maximum Advertising Constant Tone Extension Transmit Duration different than the supported minimum non-zero transmit duration, repeat steps 1–3 except that the Lower Tester writes the maximum supported transmit duration defined in IXIT [6] or 10 s, whichever is lower, in step 1.
  5. Repeat steps 1–3 except that the Lower Tester writes 0x00 (indefinite time duration) in step 1 and the Lower Tester receives advertising packets with Constant Tone Extension in step 3 for at least twice as long as the maximum supported transmit duration defined in IXIT [6] or 10 s, whichever is lower.

- Expected Outcome

  Pass verdict

  When a non-zero Advertising Constant Tone Extension Transmit Duration value is written, the IUT transmits advertising packets with Constant Tone Extension for the written duration and switches to transmitting advertising packets without Constant Tone Extension afterwards.

  When zero is written for the Advertising Constant Tone Extension Transmit Duration, the IUT transmits advertising packets with Constant Tone Extension without stopping after the maximum supported transmit duration as defined in IXIT [6].

### CTES/SR/SP/BV-08-C [Writing Advertising Constant Tone Extension Interval Behavior]

- Test Purpose

  Verify that the IUT advertises with Constant Tone Extensions at the interval specified by the Advertising Constant Tone Extension Interval characteristic.

- Reference

  [3] 3.5.1

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Advertising Constant Tone Extension Interval characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x02 (Enable AoD Constant Tone Extension in advertising packets).
  - The Lower Tester is configured to scan for advertising packets from the IUT throughout the test.
  - The IUT is configured to transmit advertising packets.

- Test Procedure

  1. The Lower Tester writes the minimum supported Advertising Constant Tone Extension Interval as defined in IXIT [6] to the Advertising Constant Tone Extension Interval characteristic.
  2. The Lower Tester terminates the ATT Bearer connection.
  3. The Lower Tester receives advertising packets from the IUT with Constant Tone Extension at the interval specified in step 1 for at least 3 intervals.
  4. If the IUT supports a maximum Advertising Constant Tone Extension Interval different than the supported minimum interval, repeat steps 1–3 except that in step 1 the Lower Tester writes the lowest value of maximum supported interval defined in IXIT [6] or 10 s.

- Expected Outcome

  Pass verdict

  The IUT transmits advertising packets with Constant Tone Extension at the written interval.

### CTES/SR/SP/BV-09-C [Writing Advertising Constant Tone Extension PHY Behavior]

- Test Purpose

  Verify that the IUT advertises with Constant Tone Extensions on the PHY specified by the Advertising Constant Tone Extension PHY characteristic when enabled.

- Reference

  [3] 3.6.1

- Initial Condition
  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Advertising Constant Tone Extension PHY characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x02 (Enable AoD Constant Tone Extension in advertising packets).
  - The Lower Tester is configured to scan for advertising packets from the IUT throughout the test.
  - The IUT is configured to transmit advertising packets with the minimum advertising interval.
- Test Procedure
  1. The Lower Tester writes 0 (LE 1M PHY) to the Advertising Constant Tone Extension Transmit Duration characteristic.
  2. The Lower Tester terminates the ATT Bearer connection.
  3. The Lower Tester receives advertising packets from the IUT with Constant Tone Extension on the PHY specified in step 1.
  4. If the IUT supports using the LE 2M PHY, repeat steps 1–3 except that the Lower Tester writes 1 (LE 2M PHY) in step 1.
- Expected Outcome

  Pass verdict

  The IUT transmits advertising packets with AoD Constant Tone Extension on the written PHY.

### CTES/SR/SP/BV-10-C [Writing Advertising Constant Tone Extension PHY Behavior, PHY Not Supported]

- Test Purpose

  Verify that the IUT rejects a write to the Advertising Constant Tone Extension PHY characteristic when the specified PHY is not supported.

- Reference

  [3] 3.6.1

- Initial Condition
  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.

- The handle of the Advertising Constant Tone Extension PHY characteristic 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 writes a value specifying a PHY that the IUT does not support to the Advertising Constant Tone Extension PHY characteristic and receives an Error Response with the Error Code set to 0xFC (Write Request Rejected).
  2. The Lower Tester terminates the ATT Bearer connection.

- Expected Outcome

  Pass verdict

  The IUT rejects the write using an Error Response with the Error Code set to 0xFC (Write Request Rejected).

### CTES/SR/SP/BV-11-C [Writing Advertising Constant Tone Extension Minimum Transmit Count Behavior]

- Test Purpose

  Verify that the IUT advertises with the minimum number of Constant Tone Extensions specified by the Advertising Constant Tone Extension Minimum Transmit Count characteristic at each Constant Tone Extension Interval.

- Reference

  [3] 3.3

- Initial Condition

  - Establish a 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. If the attribute permissions for the Constant Tone Extension Enable characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  - The handle of the Advertising Constant Tone Extension Minimum Transmit Count characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x02 (Enable AoD Constant Tone Extension in advertising packets).
  - The Lower Tester is configured to scan for advertising packets from the IUT throughout the test.
  - The IUT is configured to transmit advertising packets.

- Test Procedure

  1. The Lower Tester writes 0x01 to the Advertising Constant Tone Extension Minimum Transmit Count characteristic.
  2. The Lower Tester terminates the ATT Bearer connection.

3. The Lower Tester receives from the IUT at least one Constant Tone Extension inside a Constant Tone Extension Interval.
4. Repeat steps 1–3 except that the Lower Tester writes 0x0F in step 1.

- Expected Outcome

  Pass verdict

  The IUT transmits advertising packets with at least one Constant Tone Extension inside a Constant Tone Extension Interval.

### CTES/SR/SP/BI-01-C [Writing Constant Tone Extension Enable Behavior, Advertising with AoD Constant Tone Extension, Ignore RFU Bits]

- Test Purpose

  Verify that the IUT ignores the RFU bits set in a Constant Tone Extension Enable characteristic value that is written and enables or disables advertising with AoD Constant Tone Extension.

- Reference

  [3] 1.1.2, 3.1.1

- Initial Condition

  - The handle of the Constant Tone Extension Enable characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x00 (All Disabled).

- Test Procedure

  Same as CTES/SR/SP/BV-01-C [Writing Constant Tone Extension Enable Behavior, Advertising with AoD Constant Tone Extension]. The Lower Tester sets all RFU bits to ‘1’ when writing the characteristic value.

- Expected Outcome

  Pass verdict

  Same as CTES/SR/SP/BV-01-C [Writing Constant Tone Extension Enable Behavior, Advertising with AoD Constant Tone Extension].

### CTES/SR/SP/BI-02-C [Writing Constant Tone Extension Enable Behavior, AoA Connection Constant Tone Extension Response, Ignore RFU Bits]

- Test Purpose

  Verify that the IUT ignores the RFU bits set in a Constant Tone Extension Enable characteristic value that is written and enables or disables AoA Connection Constant Tone Extension Responses.

- Reference

  [3] 1.1.2, 3.1.1

- Initial Condition
  - The handle of the Constant Tone Extension Enable characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x00 (All Disabled).
- Test Procedure

  Same as CTES/SR/SP/BV-03-C [Writing Constant Tone Extension Enable Behavior, AoA Connection Constant Tone Extension Response]. The Lower Tester sets all RFU bits to '1' when writing the characteristic value.

- Expected Outcome

  Pass verdict

  Same as CTES/SR/SP/BV-03-C [Writing Constant Tone Extension Enable Behavior, AoA Connection Constant Tone Extension Response].

### CTES/SR/SP/BI-03-C [Writing Advertising Constant Tone Extension Minimum Length Behavior, Ignore RFU Bits]

- Test Purpose

  Verify that the IUT ignores the RFU bits set in an Advertising Constant Tone Extension Minimum Length characteristic value that is written and advertises with Constant Tone Extensions of the length specified by the characteristic value.

- Reference

  [3] 1.1.2, 3.2.1

- Initial Condition
  - The handle of the Advertising Constant Tone Extension Minimum Length characteristic referenced in the test case below has been previously discovered by the Lower Tester or is known to the Lower Tester by other means.
  - The Constant Tone Extension Enable characteristic is set to value 0x02 (Enable AoD Constant Tone Extension in advertising packets).
  - The Lower Tester is configured to scan for advertising packets from the IUT throughout the test.
  - The IUT is configured to transmit advertising packets.
- Test Procedure

  Same as CTES/SR/SP/BV-05-C [Writing Advertising Constant Tone Extension Minimum Length Behavior]. The Lower Tester sets all RFU bits to '1' when writing the characteristic value.

- Expected Outcome

  Pass verdict

  Same as CTES/SR/SP/BV-05-C [Writing Advertising Constant Tone Extension Minimum Length Behavior].

### CTES/SR/SP/BI-04-C [Writing Advertising Constant Tone Extension Minimum Transmit Count Behavior, Out of Range]

- Test Purpose

  Verify that the IUT rejects a write to the Advertising Constant Tone Extension Minimum Transmit Count characteristic when the value is outside of the supported range.

- Reference

  [3] 3.3.1

- Initial Condition

  - The handle of the Advertising Constant Tone Extension Minimum Transmit Count characteristic 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 establishes an ATT Bearer connection with the IUT using LE transport. If the attribute permissions for the Advertising Constant Tone Extension Minimum Transmit Count characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.
  2. The Lower Tester writes a random value greater than 15 to the Advertising Constant Tone Extension Minimum Transmit Count characteristic and receives an Error Response with the Error Code set to 0xFF (Out of Range).

- Expected Outcome

  Pass verdict

  The IUT rejects the write using an Error Response with the Error Code set to 0xFF (Out of Range).

### CTES/SR/SP/BI-05-C [Writing Advertising Constant Tone Extension Interval Behavior, Out of Range]

- Test Purpose

  Verify that the IUT rejects a write to the Advertising Constant Tone Extension Interval characteristic when the value is outside of the supported range.

- Reference

  [3] 3.5.1

- Initial Condition

  - The handle of the Advertising Constant Tone Extension Interval characteristic 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 establishes an ATT Bearer connection with the IUT using LE transport. If the attribute permissions for the Advertising Constant Tone Extension Interval characteristic have been set by the IUT, and it has specific authentication requirements or authorization requirements, the established connection meets these requirements.

2. The Lower Tester writes a random value lower than 0x0006 (7.5 ms) to the Advertising Constant Tone Extension Interval characteristic and receives an Error Response with the Error Code set to 0xFF (Out of Range).

- Expected Outcome

  Pass verdict

  The IUT rejects the write using an Error Response with the Error Code set to 0xFF (Out of Range).

# 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 CTES [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) |
|---|---|---|
| CTES 2/1 | Constant Tone Extension Service | CTES/SR/SGGIT/SER/BV-01-C |
| CTES 2/2 | Constant Tone Extension Enable Characteristic | CTES/SR/SGGIT/CHA/BV-01-C |
| CTES 2/2 AND CTES 2a/1 | Constant Tone Extension Enable Characteristic - AoA supported | CTES/SR/SP/BV-03-C<br>CTES/SR/SP/BI-02-C |
| CTES 2/2 AND CTES 2a/2 | Constant Tone Extension Enable Characteristic - AoD supported | CTES/SR/SP/BV-01-C<br>CTES/SR/SP/BI-01-C |
| CTES 2/2 AND NOT CTES 2a/1 | Constant Tone Extension Enable Characteristic - AoA not supported | CTES/SR/SP/BV-04-C |
| CTES 2/2 AND NOT CTES 2a/2 | Constant Tone Extension Enable Characteristic - AoD not supported | CTES/SR/SP/BV-02-C |
| CTES 2/3 AND CTES 3/1 | Advertising Constant Tone Extension Minimum Length Characteristic | CTES/SR/SGGIT/CHA/BV-02-C<br>CTES/SR/SP/BV-05-C<br>CTES/SR/SP/BV-06-C<br>CTES/SR/SP/BI-03-C |
| CTES 2/4 AND CTES 3/1 | Advertising Constant Tone Extension Minimum Transmit Count Characteristic | CTES/SR/SGGIT/CHA/BV-03-C<br>CTES/SR/SP/BV-11-C<br>CTES/SR/SP/BI-04-C |
| CTES 2/5 AND CTES 3/1 | Advertising Constant Tone Extension Transmit Duration Characteristic | CTES/SR/SGGIT/CHA/BV-04-C<br>CTES/SR/SP/BV-07-C |
| CTES 2/6 AND CTES 3/1 | Advertising Constant Tone Extension Interval Characteristic | CTES/SR/SGGIT/CHA/BV-05-C<br>CTES/SR/SP/BV-08-C<br>CTES/SR/SP/BI-05-C |

| Item | Feature | Test Case(s) |
|---|---|---|
| CTES 2/7 AND CTES 3/1 | Advertising Constant Tone Extension PHY Characteristic | CTES/SR/SGGIT/CHA/BV-06-C<br>CTES/SR/SP/BV-09-C<br>CTES/SR/SP/BV-10-C |

*Table 5.1: Test case mapping*

# 6 Revision history and acknowledgments

***Revision History***

| Publication Number | Revision Number | Date | Comments |
|---|---|---|---|
| | D09r00–r03 | 2017-07-11 – 2017-10-20 | Initial draft based on specification D09r02_clean_PS_YK_fb_DFWG.<br>Updated for “Supplemental” rename to “Constant Tone Extension”.<br>Reworked references to GATT TS instead to specify the appropriate GATT procedures.<br>Reworked Characteristic Read and Characteristic Write tests to cover those procedures when meeting security permissions requirements and when not.<br>Removed duplicate initial conditions.<br>Reworded test steps that used “should” to stop using “should”.<br>Reworked tests specifying establishing ATT Bearer connecitons and terminating them multiple times to specify establishing one once.<br>Removed Test Case Applicable column and text from TCMT section.<br>Removed CR tests to match requirements in specification D09r03.<br>Added text to clarify who initiates connection in the Write tests. |
| | D1.0.0 r00–r07 | 2018-01-25 – 2020-11-12 | Updated based on specification 1.0r00.<br>Incorporated E10444, E10550 and feedback from PTS.<br>Incorporated E11314 and E14444.<br>Incorporated E11603.<br>Updated based on TemplateV2019.<br>Removed instances of “expects” phrasing.<br>Incorporated E12989.<br>Updated to address BTI feedback and update TCMT for changes in ICS (E15737).<br>Update to Contributors table and disclaimer.<br>BTI comment resolution: Added setup preambles for establishing connections between the Lower Tester and IUT and updated test cases to reference these.<br>Updated step numbers affected by modifying test procedures for new setup preambles.<br>Updated Table 4.1 to remove unused conventions |
| 0 | p0 | 2021-01-19 | Approved by BTI on 2020-12-06. CTES v1.0 adopted by BoD on 2021-01-12. Prepared for publication. |

| Publication Number | Revision Number | Date | Comments |
|---|---|---|---|
| | p1r00 | 2021-09-30 | TSE 17477 (rating 3): Updated the TCMT for CTES/SR/SP/BV-01-C – -04-C and CTES/SR/SP/BI-01-C – -02-C to include the new ICS item.<br>Performed template-related fixes. Updated Scope and the introduction text before the TCMT to align with the template. Updated copyright page to align with v2 of the DNMD. |
| 1 | p1 | 2022-01-25 | Approved by BTI on 2022-01-06. Prepared for TCRL 2021-2 publication. |

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