

Elapsed Time Service (ETS)

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

- [1] Bluetooth Core Specification, Version 4.2 or later
- [2] Test Strategy and Terminology Overview
- [3] Elapsed Time Service Specification, Version 1.0
- [4] ICS Proforma for Elapsed Time Service
- [5] IXIT Proforma for Elapsed Time Service
- [6] Characteristic and Descriptor descriptions are accessible via the [Bluetooth SIG Assigned Numbers](#)
- [7] GATT Test Suite, GATT.TS
- [8] GATT Specification Supplement

2.2 Definitions

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

2.3 Acronyms and abbreviations

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

3 Test Suite Structure (TSS)

3.1 Overview

The Elapsed Time Service (ETS) requires the presence of ATT, GAP, GATT, SDP (BR/EDR), and SM (LE). This is illustrated in [Figure 3.1](#).

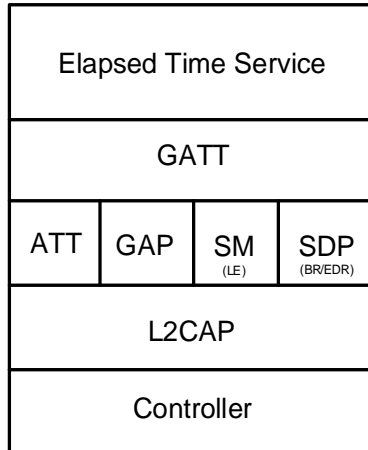


Figure 3.1: Elapsed Time Service test model

3.2 Test Strategy

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

The test equipment implements 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 relies on IXIT values that are described in the respective test cases that make use of the IXIT value.

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.

Certain tests in this Test Suite require two independent Lower Testers to be run concurrently against the IUT.

3.3 Test groups

The following test groups have been defined:

- Generic GATT Integrated Tests
- Configure and receive indication
- Characteristic write
- Service Error Handling

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 [7] 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>
ETS	Elapsed Time Service
Identifier Abbreviation	Role Identifier <IUT role>
SR	Server Role
Identifier Abbreviation	Reference Identifier <GGIT test group>
SGGIT	Server Generic GATT Integrated Tests
Identifier Abbreviation	Reference Identifier <GGIT class>
CHA	Characteristic
SDP	Validate SDP Record
SER	Service
Identifier Abbreviation	Features and Behaviors Identifier <feat>
CDRW	Characteristic Descriptor Read and Write (Configure Indication)
CW	Characteristic Write
SCI	Service Characteristic Indications
SEH	Service Error Handling

Table 4.1: ETS 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 in this section are used to achieve specific conditions on the IUT and the test equipment within the tests defined in this document. The preambles here are commonly used to establish initial conditions.

4.2.1 ATT Bearer on LE transport

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

4.2.2 ATT Bearer on BR/EDR transport

- Preamble Procedure
 1. Establish a BR/EDR transport connection between the IUT and the Lower Tester.
 2. Establish an L2CAP channel (PSM 0x001F) 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 [7] in Section 6.3, Server test procedures (SGGIT), using Table 4.2 below as input:

TCID	Service / Characteristic	Reference	Properties	Value Length (Octets)	Type
ETS/SR/SGGIT/SER/BV-01-C [Service GGIT – Elapsed Time]	Elapsed Time Service	[3] 2	-	-	Not defined
ETS/SR/SGGIT/SDP/BV-02-C [SDP Record – Elapsed Time]	Elapsed Time Service	[3] 4	-	-	-
ETS/SR/SGGIT/CHA/BV-03-C [Characteristic GGIT – Current Elapsed Time]	Current Elapsed Time Characteristic	[3] 3, 3.1	0x22 (Read, Indicate)	11	-
ETS/SR/SGGIT/CHA/BV-04-C [Characteristic GGIT – Current Elapsed Time with write]	Current Elapsed Time Characteristic	[3] 3, 3.1	0x2A (Read, Indicate, Write)	11, Skip-Write	-

Table 4.2: Input for the GGIT Server test procedure

4.4 Configure and receive indication

ETS/SR/CDRW/BV-01-C [Configure Current Elapsed Time characteristic for indication]

- Test Purpose

Verify that the IUT can be configured for indications of the Current Elapsed Time characteristic values, and that the CCCD value can be read.
- Reference

[3] 3
- Initial Condition
 - Establish an ATT Bearer connection between the Lower Tester and the IUT as described in Section 4.2.1, if using an LE transport, or Section 4.2.2 if using a BR/EDR transport.
 - The handle of the Current Elapsed Time characteristic value 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 CCCD of the Current Elapsed Time characteristic 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.
- Test Procedure
 1. Disable indication by writing value 0x0000 to the CCCD of the characteristic.
 2. The Lower Tester reads the value of the CCCD.
 3. Enable indication by writing value 0x0002 to the CCCD of the characteristic.
 4. The Lower Tester reads the value of the CCCD.
- Expected Outcome

Pass verdict

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

4.4.1 Current Elapsed Time characteristic indication

- Test Purpose

Verify that the IUT can send an indication of the Current Elapsed Time characteristic with the updated <Time_Value field> as described in Table 4.3.
- Reference

[3] 3.1.2.2
- Initial Condition
 - The Lower Tester has performed a bonding procedure and is bonded with the IUT.
 - The handle of the Current Elapsed Time characteristic 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 Lower Tester knows the features supported by the IUT (e.g., by executing test case ETS/SR/SGGIT/CHA/BV-03-C [Characteristic GGIT – Current Elapsed Time]).

- The Current Elapsed Time characteristic is configured for indication by the Lower Tester.
- Clock Needs To Be Set flag is 1.
- The Lower Tester and the IUT are disconnected.
- Test Case Configuration

Test Case	Time_Value field
ETS/SR/SCI/BV-01-C [Characteristic indication with UTC Time]	UTC time
ETS/SR/SCI/BV-02-C [Characteristic indication with Local Time]	Local time
ETS/SR/SCI/BV-03-C [Characteristic indication with Tick Counter]	Tick counter

Table 4.3: Current Elapsed Time characteristic indication test cases

- Test Procedure
 1. The Upper Tester induces the IUT to change the <Time_Value field> described in [Table 4.3](#) to a new value via a Current Elapsed Time characteristic write or via the IUT's UI.
 2. Establish an ATT Bearer connection between the Lower Tester and the IUT as described in [Section 4.2.1](#) if using an LE transport, or [Section 4.2.2](#) if using a BR/EDR transport.
 3. The Lower Tester receives an ATT_HANDLE_VALUE_IND PDU containing the Current Elapsed Time characteristic handle and value from the IUT.
 4. The Lower Tester sends an ATT_HANDLE_VALUE_CFM PDU to the IUT.

- Expected Outcome

Pass verdict

The IUT sends an indication of the Current Elapsed Time characteristic including the updated <Time_Value field>.

[ETS/SR/SCI/BV-04-C \[Characteristic indication to other connected client\]](#)

- Test Purpose

Verify that the IUT can send an indication with the appropriate value, to a connected client, after a different connected client writes a new time value to the Current Elapsed Time characteristic.

- Reference

[\[3\]](#) 3.1.2.2

- Initial Condition

- Establish an ATT Bearer connection between Lower Tester 1 and the IUT as described in [Section 4.2.1](#), if using an LE transport, or [Section 4.2.2](#) if using a BR/EDR transport.
- The handle of the Current Elapsed Time characteristic has been previously discovered by Lower Testers 1 and 2 during the test procedure in [Section 4.3](#) or is known to the Lower Testers by other means.
- The Current Elapsed Time characteristic is configured for indication by Lower Tester 2, and Lower Tester 2 is connected to the IUT.
- Lower Tester 1 knows the features supported by the IUT (e.g., by executing test case [ETS/SR/SGGIT/CHA/BV-03-C \[Characteristic GGIT – Current Elapsed Time\]](#)).
- Clock Needs To Be Set flag is 1.

- Test Procedure
 1. Lower Tester 1 writes a new time value to the Current Elapsed Time characteristic (e.g., by executing one of the test cases in Section 4.5).
 2. Lower Tester 2 receives an ATT_HANDLE_VALUE_IND PDU, from the IUT, containing the Current Elapsed Time characteristic handle and value.
 3. Lower Tester 2 sends an ATT_HANDLE_VALUE_CFM PDU to the IUT.

- Expected Outcome

Pass verdict

The IUT sends an indication of the Current Elapsed Time characteristic, with the updated time value increased by the natural progression of time, to Lower Tester 2.

4.5 Characteristic write

- Test Purpose

Write and verify that the Current Elapsed Time characteristic values required by the service are compliant.

- Reference

[3] 3.1.2.3

- Initial Condition

- Establish an ATT Bearer connection between the Lower Tester and the IUT as described in Section 4.2.1, if using an LE transport, or Section 4.2.2 if using a BR/EDR transport.
- The handle of the Current Elapsed Time characteristic 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 bond, then perform a bonding procedure.
- The Lower Tester knows the features supported by the IUT (e.g., by executing test case ETS/SR/SGGIT/CHA/BV-03-C [Characteristic GGIT – Current Elapsed Time]).
- Clock Needs To Be Set flag is 1.

- Test Case Configuration

Test Case	Value [8]
ETS/SR/CW/BV-01-C [Characteristic write of a UTC time without TZ/DST]	New UTC Time_Value without TZ/DST offset
ETS/SR/CW/BV-02-C [Characteristic write of a UTC time with TZ/DST]	New UTC Time_Value with TZ/DST offset
ETS/SR/CW/BV-03-C [Characteristic write of a Local time without TZ/DST]	New Local time Time_Value without TZ/DST offset
ETS/SR/CW/BV-04-C [Characteristic write of a Local time with TZ/DST]	New Local time Time_Value with TZ/DST offset
ETS/SR/CW/BV-05-C [Characteristic write of a Tick counter]	New Tick counter Time_Value

Table 4.4: Characteristic Write Value test cases

- Test Procedure
 1. The Lower Tester sends an ATT_WRITE_REQ PDU to the IUT to write the characteristic <Value> described in [Table 4.4](#).
 2. The Lower Tester sends an ATT_READ_REQ PDU to verify that the value specified in step 1 was written in the IUT.

- Expected Outcome

Pass verdict

The IUT sends a correctly formatted ATT_WRITE_RSP PDU to the Lower Tester.

The IUT sends an ATT_READ_RSP PDU reporting the value delivered in step 1, increased by the natural progression of time.

The flag of Timestamp Is From The Current Timeline is set to 1.

4.6 Service Error Handling

Verify the compliant operation of the IUT when the Current Elapsed Time characteristic is written with values outside defined ranges, or considered invalid or unexpected.

4.6.1 Error responses to invalid characteristic write

- Test Purpose

For each test case in [Table 4.5](#), verify that the IUT responds with the appropriate error response.
- Reference

[\[3\]](#) 3.1.2.3
- Initial Condition
 - Establish an ATT Bearer connection between the Lower Tester and the IUT as described in Section [4.2.1](#), if using an LE transport, or Section [4.2.2](#) if using a BR/EDR transport.
 - The handle of the Current Elapsed Time characteristic 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 bond, then perform a bonding procedure.
 - The Lower Tester knows the flags used by the IUT (e.g., by executing test case [ETS/SR/SGGIT/CHA/BV-03-C \[Characteristic GGIT – Current Elapsed Time\]](#)).
 - Clock Needs To Be Set flag is 0.
 - The TSPX_iut_time_sources_of_too_low_quality is known from the IXIT [\[5\]](#).
 - The TSPX_iut_out_of_range_time_value is known from the IXIT [\[5\]](#).
- Test Case Configuration

Test Case	Elapsed_Time field value	Error Response Code
ETS/SR/SEH/BI-01-C [Time Source Quality Too Low]	A valid time value with the Time_Sync_Source_Type field with the value described in [5] .	Time Source Quality Too Low (0x80)
ETS/SR/SEH/BI-02-C [Incorrect Time Format]	A valid time value with a Flags field that does not have the flags set as used by the IUT.	Incorrect Time Format (0x81)

Test Case	Elapsed_Time field value	Error Response Code
ETS/SR/SEH/BI-03-C [Out of Range]	Time_Value field with the value described in [5] .	Out of Range (0xFF)

Table 4.5: Characteristic write error test cases

- Test Procedure
 1. The Lower Tester sends an ATT_WRITE_REQ PDU, with the <Elapsed_Time field value> described in [Table 4.5](#), to the IUT.
 2. The Lower Tester receives an ATT_ERROR_RSP PDU with the code described in [Table 4.5](#).

- Expected Outcome

Pass verdict

The IUT sends an ATT_ERROR_RSP PDU with the code described in [Table 4.5](#).

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 ETS [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. Further details about the function of the TCMT are elaborated in [2].

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

Item	Feature	Test Case(s)
ETS 2/1 OR ETS 2/2	Elapsed Time Service	ETS/SR/SGGIT/SER/BV-01-C
ETS 2/1	SDP Record – Elapsed Time	ETS/SR/SGGIT/SDP/BV-02-C
ETS 4/1 AND NOT ETS 4/2	Current Elapsed Time characteristic	ETS/SR/SGGIT/CHA/BV-03-C
ETS 4/1	Current Elapsed Time characteristic indication	ETS/SR/CDRW/BV-01-C
ETS 4/2	Current Elapsed Time characteristic with write	ETS/SR/SGGIT/CHA/BV-04-C
ETS 3/1 AND ETS 4/1 AND (ETS 4/2 OR ETS 3/7)	Characteristic indication with UTC time	ETS/SR/SCI/BV-01-C
ETS 3/2 AND ETS 4/1 AND (ETS 4/2 OR ETS 3/7)	Characteristic indication with Local time	ETS/SR/SCI/BV-02-C
ETS 3/3 AND ETS 4/1 AND (ETS 4/2 OR ETS 3/7)	Characteristic indication of a Tick counter time value	ETS/SR/SCI/BV-03-C
ETS 3/5 AND ETS 4/2	Characteristic indication to other connected client	ETS/SR/SCI/BV-04-C
ETS 3/1 AND ETS 4/2 AND NOT ETS 3/4	Characteristic write of a UTC time without TZ/DST	ETS/SR/CW/BV-01-C
ETS 3/1 AND ETS 3/4 AND ETS 4/2	Characteristic write of a UTC time with TZ/DST	ETS/SR/CW/BV-02-C
ETS 3/2 AND ETS 4/2 AND NOT ETS 3/4	Characteristic write of a Local time without TZ/DST	ETS/SR/CW/BV-03-C

Item	Feature	Test Case(s)
ETS 3/2 AND ETS 3/4 AND ETS 4/2	Characteristic write of a Local time with TZ/DST	ETS/SR/CW/BV-04-C
(ETS 3/1 OR ETS 3/2) AND ETS 4/2 AND ETS 3/6	Time Source Quality Too Low	ETS/SR/SEH/BI-01-C
ETS 4/2	Insufficient precision or Out of Range response	ETS/SR/SEH/BI-02-C ETS/SR/SEH/BI-03-C
ETS 3/3 AND ETS 4/2	Characteristic write of a tick counter time value	ETS/SR/CW/BV-05-C

Table 5.1: Test case mapping

6 Revision history and acknowledgments

Revision History

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