Electronic Shelf Label Service (ESLS)

***Bluetooth*® Test Suite**

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Contents

1 Scope

This Bluetooth document contains the Test Suite Structure (TSS) and test cases to test the implementation of the Bluetooth Electronic Shelf Label 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], [2], and [3].

[1] Bluetooth Core Specification, Version 5.4 or later

[2] Test Strategy and Terminology Overview

[3] Electronic Shelf Label Service Specification, Version 1.0

[4] ICS Proforma for Electronic Shelf Label Service, ESLS.ICS

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

[6] GATT Test Suite, GATT.TS

[7] IXIT Proforma for Electronic Shelf Label Service

2.2 Definitions

In this Bluetooth document, the definitions from [1], [2], and [3] apply.

2.3 Acronyms and abbreviations

In this Bluetooth document, the definitions, acronyms, and abbreviations from [1], [2], and [3] apply.

3 Test Suite Structure (TSS)

3.1 Overview

The Electronic Shelf Label Service requires the presence of GAP, SM, ATT, L2CAP, and GATT. This is illustrated in Figure 3-1.

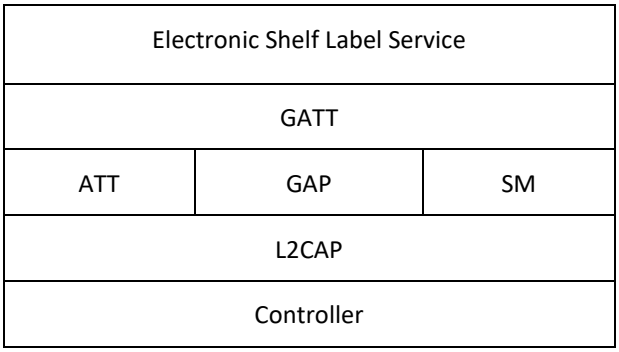

Figure 3-1: Electronic Shelf Label Service test model

3.2 Test Strategy

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

The test equipment provides an implementation of the Radio Controller and the parts of the Host needed to perform the test cases defined in this Test Suite. A Lower Tester acts as the IUT's peer device and interacts with the IUT over-the-air interface. The configuration, including the IUT, needs to implement similar capabilities to communicate with the test equipment. For some test cases, it is necessary to stimulate the IUT from an Upper Tester. In practice, this could be implemented as a special test interface, a Man Machine Interface (MMI), or another interface supported by the IUT.

The 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 tests also include coverage for optional displays, sensors, and LEDs.

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.

- Characteristics Length Validation

  Verify the characteristics with variable lengths.

- ESL Control Point procedures

  Verify the behavior of procedures triggered by writing opcodes to the ESL Control Point characteristic.

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 [6] 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>**
ESLS	Electronic Shelf Label Service
Identifier Abbreviation	**Role Identifier <IUT role>**
SR	Server
Identifier Abbreviation	**Reference Identifier <GGIT test group>**
SGGIT	Server Generic GATT Integrated Tests
Identifier Abbreviation	**Reference Identifier <GGIT class>**
CHA	Characteristic
SER	Service
Identifier Abbreviation	**Feature Identifier <feat>**
ECP	ESL Control Point procedures
UPD	Updating state

Table 4.1: ESLS 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. 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

4.2.1 ATT Bearer on LE Transport

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 EATT Bearer on LE Transport

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.

4.2.3 ESL Control Point preamble

1. 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 Section 4.2.2 if using EATT over an LE transport.
2. The handle of the ESL 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 ESL 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.
4. The Lower Tester performs a Bonding procedure.
5. The Lower Tester enables notifications by writing the value 0x0001 using the GATT Write Characteristic Descriptor sub-procedure for the ESL Control Point CCCD.

4.2.4 Updating state

- Preamble Purpose

  The IUT is configured and put in the updating state by the Lower Tester access point. The Lower Tester sets the ESL Address, the AP Sync Key, and the ESL Response Key.

- Reference

  [3] 2.7.3.4

- Initial Condition

  - The IUT has an active ATT or EATT Bearer connection with the Lower Tester.
  - The IUT is bonded only with the Lower Tester.

- Preamble Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the ESL Address characteristic with an ESL Address.
  2. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the AP Synchronization Key characteristic with an AP Synchronization Key.
  3. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the ESL Response Key characteristic with an ESL Response Key.
  4. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the ESL Current Absolute Time Characteristic with a current time.
  5. The Lower Tester disconnects the active connection.
  6. The Lower Tester initiates a connection with the IUT.

4.3 Generic GATT Integrated Tests

Execute the Generic GATT Integrated Tests defined in Section 6.3, Server Test Procedures, in [6] using Table 4.2 below as input:

TCID	Service / Characteristic / Descriptor	Reference	Properties	Value Length (Octets)	Type
ESLS/SR/SGGIT/SER/BV-01-C [Service GGIT – Electronic Shelf Label]	Electronic Shelf Label	[3] 2.6	-	-	Primary Service
ESLS/SR/SGGIT/CHA/BV-01-C [Characteristic GGIT – ESL Address]	ESL Address Characteristic	[3] 3.1	Mandatory: 0x08 (Write)	2	-
ESLS/SR/SGGIT/CHA/BV-02-C [Characteristic GGIT – AP Sync Key Material]	AP Sync Key Characteristic	[3] 3.2	Mandatory: 0x08 (Write)	24	-
ESLS/SR/SGGIT/CHA/BV-03-C [Characteristic GGIT – ESL Response Key Material]	ESL Response Key	[3] 3.3	Mandatory: 0x08 (Write)	24	-
ESLS/SR/SGGIT/CHA/BV-04-C [Characteristic GGIT – ESL Current Absolute Time]	ESL Current Absolute Time Characteristic	[3] 3.4	Mandatory: 0x08 (Write)	4	-
ESLS/SR/SGGIT/CHA/BV-05-C [Characteristic GGIT – Display Information]	Display Information Characteristic	[3] 3.5	Mandatory: 0x02 (Read)	Skip	-
ESLS/SR/SGGIT/CHA/BV-06-C [Characteristic GGIT – Image Information]	Image Information Characteristic	[3] 3.6	Mandatory: 0x02 (Read)	1	-
ESLS/SR/SGGIT/CHA/BV-07-C [Characteristic GGIT – Sensor Information]	Sensor Information Characteristic	[3] 3.7	Mandatory: 0x02 (Read)	Skip	-
ESLS/SR/SGGIT/CHA/BV-08-C [Characteristic GGIT – LED Information]	LED Information Characteristic	[3] 3.8	Mandatory: 0x02 (Read)	Skip	-
ESLS/SR/SGGIT/CHA/BV-09-C [Characteristic GGIT – ESL Control Point]	ESL Control Point Characteristic	[3] 3.9	Mandatory: 0x1C (Write Without Response, Write, Notify)	Skip	-

Table 4.2: Generic GATT Integrated test configuration

4.4 GATT Characteristics

ESLS/SR/CHA/BV-01-C [Current Absolute Time]

- Test Purpose

  Verify that the Server IUT sets the system time.

- Reference

  [3] 3.4

- 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 Section 4.2.2 if using EATT over an LE transport.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Current Absolute Time characteristic with a value of 123456.
  2. 5 s after step 1, the Upper Tester verifies that the IUT current system time is larger than 123456.
  3. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Current Absolute Time characteristic with a value of 1357.
  4. 5 s after step 3, the Upper Tester verifies that the IUT current system time is between 6357 and 123456.

- Expected Outcome

  Pass verdict

  In step 2, the IUT current system time is between 128456 and 131456.

  In step 4, the IUT current system time is between 6357 and 123456.

4.4.1 Characteristics Validation

ESLS/SR/CHA/BV-02-C [Display Information Characteristic]

- Test Purpose

  Verify that the Server IUT responds to the Lower Tester Display Information Read characteristic with the correct number of Display Data Structures with each Display correctly populated.

- Reference

  [3] 3.5

- 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 Section 4.2.2 if using EATT over an LE transport.
  - The number of displays is defined by the TSPX_num_displays IXIT value.
  - The list of the width of each display is defined by the TSPX_display_width_array IXIT value.
  - The list of the height of each display is defined by the TSPX_display_height_array IXIT value.
  - The list of the type of each display is defined by the TSPX_display_type_array IXIT value.

- Test Procedure

  1. The Lower Tester executes the GATT Characteristic Value Read procedure for the Display Information characteristic.

- Expected Outcome

  Pass verdict

  Each Display Data Structure has valid Width, Height, and Display_Type values set to the values declared in the relative element of TSPX_display_width_array, TSPX_display_height_array, and TSPX_display_type_array.

ESLS/SR/CHA/BV-03-C [Sensor Information Characteristic]

- Test Purpose

  Verify that the Server IUT responds to the Lower Tester Sensor Information Read characteristic with the correct number of Sensor Data Structures with each Sensor Data correctly populated.

- Reference

  [3] 3.7

- 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 Section 4.2.2 if using EATT over an LE transport.
  - The sensor type size array is defined by the TSPX_sensor_size_array IXIT value.
  - The sensor type array is defined by the TSPX_sensor_type_array IXIT value.

- Test Procedure

  1. The Lower Tester executes the GATT Characteristic Value Read procedure for the Sensor Information characteristic.

- Expected Outcome

  Pass verdict

  Each Sensor Data Structure has Size and Sensor_Type values set to the values declared in the relative element of TSPX_sensor_size_array and TSPX_sensor_type_array. When the Sensor_Size is 0x00, the Sensor_Type is 2 octets. When the Sensor_Size is 0x01, the Sensor_Type is 4 octets.

ESLS/SR/CHA/BV-04-C [LED Information Characteristic Length]

- Test Purpose

  Verify that the Server IUT responds to the Lower Tester Sensor Information Read characteristic with the proper parameters for each LED.

- Reference

  [3] 3.8

- 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 Section 4.2.2 if using EATT over an LE transport.
  - The number of LEDs is defined by the TSPX_num_leds IXIT value.
- Test Procedure
  1. The Lower Tester executes the GATT Characteristic Value Read procedure for the LED Information characteristic.
- Expected Outcome

  Pass verdict

  The length of the LED Information characteristic, in octets, equals TSPX_num_leds.

ESLS/SR/CHA/BI-01-C [Invalid ESL Address]

- Test Purpose

  Verify that the Server IUT rejects invalid ESL Addresses.
- Reference

  [3] 3.1
- 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 Section 4.2.2 if using EATT over an LE transport.
- Test Procedure
  1. The Lower Tester executes the GATT Characteristic Value Write procedure for the ESL Address characteristic with bits 0 to 7 set to 0b1 and bits 8 to 14 set to a random bit.
  2. The IUT sends an ATT_ERROR_RSP to the Lower Tester with error code set to Value Not Allowed (0x13).
- Expected Outcome

  Pass verdict

  In step 2, the IUT sends an ATT_ERROR_RSP PDU to the Lower Tester with the Value Not Allowed error.

4.4.2 Information characteristic

- Test Purpose

  Verify that the Server IUT with one device returns only one element.
- 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 Section 4.2.2 if using EATT over an LE transport.

- Test Case Configuration

TCID	Reference	Element Characteristic
ESLS/SR/CHA/BV-05-C [Information Characteristic, One Display]	[3] 3.5.2	Display Information
ESLS/SR/CHA/BV-06-C [Information Characteristic, One Sensor]	[3] 3.7.2	Sensor Information
ESLS/SR/CHA/BV-07-C [Information Characteristic, One LED]	[3] 3.8.2	LED Information

Table 4.3: Information Characteristic Index = 0 test cases

- Test Procedure

  1. The Lower Tester executes the GATT Characteristic Value Read procedure for the element characteristic specified in Table 4.3.
  2. The IUT returns one element.

- Expected Outcome

  Pass verdict

  In step 2, the IUT returns one element.

4.5 ESL Control Point procedures

4.5.1 Lower Tester Control Point Command

ESLS/SR/ECP/BV-01-C [Ping]

- Test Purpose

  Verify that the Server IUT responds with a Basic State ESL notification when the Lower Tester sends the Ping opcode.

- Reference

  [3] 3.9.2.1

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID, and bit 15 (RFU) set to 0b1.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure for the ESL Control Point with the Ping opcode (0x00) and ESL_ID set.
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State response.
  4. Repeat steps 1–3 with the Lower Tester executing the GATT Write Characteristic Value sub-procedure in step 2.

- Expected Outcome

  Pass verdict

  After step 2, the IUT sends a notification of the ESL Control Point with the Basic State opcode 0x10 to the Lower Tester with valid parameter values.

ESLS/SR/ECP/BV-02-C [RGB LED Control, Color]

- Test Purpose

  Verify that the Server IUT with an RGB LED responds to setting the LED Control opcode, sets the indexed LED to the requested state, and updates all required characteristics and data values in the LED Information characteristic.

- Reference

  [3] 3.9.2.10

- Initial Condition

  - The index of an RGB LED is defined by the TSPX_rgb_led_index IXIT value.
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.

  Repeat steps 2–4 for each round specified in Table 4.4.

  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Control opcode (0xB0) and:
     - ESL_ID set to the value in step 1
     - LED_Index set to the value in Table 4.4
     - Color_Red, Color_Green, and Color_Blue set to the values in Table 4.4
     - Brightness set to 0b11
     - Flashing_Pattern set to 0x00000000
     - Repeat_Type set to 0b1
     - Repeats_Duration set to 0x0
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with the LED_Index set to the value from step 2.
  4. The Upper Tester verifies that the IUT changes the LED with the LED_Index from step 2 to the colors from step 2.

Round	Red	Green	Blue	LED_Index
1	0b00	0b00	0b00	0
2	0b01	0b00	0b00	TSPX_rgb_led_index
3	0b10	0b00	0b00	TSPX_rgb_led_index
4	0b11	0b00	0b00	TSPX_rgb_led_index
5	0b00	0b11	0b00	0
6	0b00	0b00	0b11	TSPX_rgb_led_index
7	0b11	0b11	0b00	TSPX_rgb_led_index

Round	Red	Green	Blue	LED_Index
8	0b11	0b00	0b11	TSPX_rgb_led_index
9	0b00	0b11	0b11	0
10	0b11	0b11	0b11	TSPX_rgb_led_index

Table 4.4: RGB LED Control, Color rounds

- Expected Outcome

  Pass verdict

  After step 2, the IUT sends a notification of the ESL Control Point with the LED State response to the Lower Tester with valid parameter values.

  In step 4, the IUT sets the LED to the color specified in Table 4.4 and is not flashing.

ESLS/SR/ECP/BV-03-C [Monochrome LED Control, Ignore RGB Fields]

- Test Purpose

  Verify that the Server IUT with a monochrome LED ignores the RGB fields.

- Reference

  [3] 3.9.2.10

- Initial Condition

  - The index of a monochrome LED is defined by the TSPX_monochrome_led_index IXIT value.
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.

  Repeat steps 2–4 for each round specified in Table 4.5.

  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Control (0xB0) opcode, parameters as specified in Table 4.5, and:
     - ESL_ID set to the value in step 1
     - LED_Index set to TSPX_monochrome_led_index
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with the LED_Index set to the value from step 2.
  4. The Upper Tester verifies that the IUT's monochrome LED is as specified in Table 4.5.

Round	Red	Green	Blue	Brightness	Flashing Pattern	Repeat_ Type	Repeats_ Duration	Verify
1	0b00	0b00	0b00	0b11	0x00000000	0b1	0x0	LED is on
2	0b11	0b11	0b11	0b11	0xFFFFFFFF	0b1	0x0	LED is on
3	0b10	0b10	0b10	0b11	0xFFFFFFFF	0b0	0x0	LED is off

Table 4.5: Monochrome LED Control, Ignore RGB Fields rounds

- Expected Outcome

  Pass verdict

  In step 4, the IUT's monochrome LED is set as specified in Table 4.5.

4.5.2 LED Control, Repeat, and Flashing Pattern

- Test Purpose

  Verify that the Server IUT properly handles the Repeat_Type and Repeats_Duration parameters.

- Reference

  [3] 3.9.2.10

- Initial Condition

  - The index of a monochrome LED is defined by the TSPX_monochrome_led_index IXIT value.
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Case Configuration

TCID	LED_Index
ESLS/SR/ECP/BV-04-C [LED Control, Repeat, and Flashing Pattern – Monochrome LED]	TSPX_monochrome_led_index
ESLS/SR/ECP/BV-05-C [LED Control, Repeat, and Flashing Pattern – Any LED]	0

Table 4.6: LED Control, Repeat, and Flashing Pattern test cases

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.

  Repeat steps 2–4 for each round specified in Table 4.7.

  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Control opcode (0xB0) and:
     - ESL_ID set to the value from step 1
     - LED_Index set to the value in Table 4.6
     - Color_Red, Color_Green, and Color_Blue set to 0b11
     - Brightness set to 0b11
     - Flashing_Pattern set to the value in Table 4.7
     - Repeat_Type set to the value in Table 4.7
     - Repeats_Duration set to the value in Table 4.7
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to the value from step 2.
  4. The Upper Tester verifies that the LED with the LED_Index from step 2 has the flashing pattern specified in Table 4.7.

Round	Repeat _Type	Repeats_ Duration	Flashing			Pass Verdict
			Pattern	Bit Off Period	Bit On Period	
1	0b0	0	0x5555555555	0xFF (510 ms)	0x01 (2 ms)	LED off continuously
2	0b1	0	0x5555555555	0xFF (510 ms)	0x01 (2 ms)	LED on continuously
3	0b1	0xF (15 s)	0x0000001041	0x32 (100 ms)	0xFA (500 ms)	On for 500 ms, off for 500 ms, on for 500 ms, off for 500 ms, and on for 500 ms for 15 s. Ignores upper 27 bits of the pattern. LED is off after the Repeats_Duration.
4	0b0	0x3	0x0000001041	0x32 (100 ms)	0xFA (500 ms)	On for 500 ms, off for 500 ms,on for 500 ms, off for 500 ms, and on for 1 s. Repeat three times. Ignores upper 27 bits of the pattern. LED is off after the Repeats_Duration.

Table 4.7: LED Control, Repeat, and Flashing Pattern rounds

- Expected Outcome

  Pass verdict

  In step 4, the IUT sets the LED to the flashing pattern specified in Table 4.7.

  If Repeats_Duration as specified in Table 4.7 is non-zero, then the Lower Tester verifies that the LED is off after the Repeats_Duration has elapsed.

ESLS/SR/ECP/BV-06-C [LED Timed Control]

- Test Purpose

  Verify that the Server IUT properly handles the LED Timed Control and returns an error when an item is in the queue.

- Reference

  [3] 3.9.2.11

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - The queue on the IUT used for the Time Control Point commands is empty.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.

2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Control opcode (0xB0) and:
    - ESL_ID set to the value in step 1
    - LED_Index set to 0
    - Brightness set to 3
3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to 0.
4. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Current Absolute Time characteristic set to 10000 ms.
5. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Timed Control opcode (0xF0) and:
    - ESL_ID set to the value in step 1
    - LED_Index set to 0
    - Color_Red, Color_Green, and Color_Blue set to 0b00
    - Brightness set to 1
    - Flashing_Pattern set to: Pattern = 0xFFFFFFFFFF, Bit_Off_Period: 0xFA (500 ms), Bit_On_Period: 0xFA (500 ms)
    - Repeat_Type set to 0b1
    - Repeats_Duration set to 0x0
    - Absolute_Time set to 20000
6. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to 0.
7. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00) and ESL_ID set to the value in step 1.
8. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State response with the Pending LED Update bit set to True.
9. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Timed Control opcode (0xF0) and:
    - ESL_ID set to the value in step 1
    - LED_Index set to 0
    - Color_Red, Color_Green, and Color_Blue set to 0b00
    - Brightness set to 3
    - Flashing_Pattern set to: Pattern = 0xFFFFFFFFFF, Bit_Off_Period: 0xFA (500 ms), Bit_On_Period: 0xFA (500 ms)
    - Repeat_Type set to 0b1
    - Repeats_Duration set to 0x0
    - Absolute_Time set to 30000
10. The IUT sends an ATT Error response to the Lower Tester with the error code Queue Full (0x0B).
11. The Upper Tester verifies that the LED changes to 50% brightness when the absolute time is 20000.
12. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00) and ESL_ID set.
13. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State response.

- Expected Outcome

  Pass verdict

  In step 8, the Pending LED Update bit in the Basic State response is set to True.

  In step 10, the IUT returns the Queue Full error.

  The LED changes to 50% brightness when the absolute time is 20000.

  In step 13, the Pending LED Update bit in the Basic State response is set to False.

ESLS/SR/ECP/BV-07-C [Display Image]

- Test Purpose

  Verify that the Server IUT displays the requested pre-stored image on the indexed display when setting the Display Image opcode.

- Reference

  [3] 3.9.2.8

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - The IUT has preloaded images in the image storage locations with Image_Index values equal to 0 and Max_Image_Index.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Characteristic Value Read procedure for the Display Information characteristic.
  3. The Lower Tester executes the GATT Characteristic Value Read procedure for the Image Information characteristic.
  4. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Display Image opcode (0x20) and:
     - ESL_ID set to the value in step 1
     - Display_Index set to one less than the number of Display Data Structures returned in step 2
     - Image_Index set to Max_Image_index returned in step 3
  5. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Display State opcode.
  6. The Upper Tester verifies that the image in Image_Index from step 4 is displayed on the display with Display_Index from step 4.
  7. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Display Image opcode (0x20) and:
     - ESL_ID set to the value in step 1
     - Display_Index set to 0
     - Image_Index set to 0
  8. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Display State opcode.

9. The Upper Tester verifies that the image with Image_Index 0 is displayed on the display with Display_Index 0.

- Expected Outcome

  Pass verdict

  In steps 6 and 9, the IUT displays the requested image on the indexed display.

ESLS/SR/ECP/BV-08-C [Display Timed Image]

- Test Purpose

  Verify that the Server IUT displays the requested pre-stored image on the indexed display at the set Absolute Time when setting the Display Timed Image opcode. The IUT also returns an error when an item is in the queue.

- Reference

  [3] 3.9.2.9

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - The queue on the IUT used for the Time Control Point command is empty.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Characteristic Value Read procedure for the Display Information characteristic.
  3. The Lower Tester executes the GATT Characteristic Value Read procedure for the Image Information characteristic.
  4. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Current Absolute Time characteristic with a value of 30000.
  5. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Display Timed Image opcode (0x60) and:
     - ESL_ID set to the value from step 1
     - Display_Index set to 0
     - Image_Index set to 0
     - Absolute_Time set to 40000
  6. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Display State opcode.
  7. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00) and ESL_ID set.
  8. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State response and Pending Display Update set to True.
  9. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Display Timed Image opcode (0x60) and:
     - ESL_ID set to the value from step 1
     - Display_Index set to 0

    - Image_Index set to 0
    - Absolute_Time set to 45000
10. The IUT sends an ATT Error response to the Lower Tester with the error code Queue Full (0x0B).
11. The Upper Tester verifies that Display_Index 0 is set to Image_Index 0 at absolute time 40000.
12. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00) and ESL_ID set.
13. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State response and Pending Display Update set to False.

- Expected Outcome

  Pass verdict

  The IUT displays the requested image at the specified time.

  In step 8, the IUT sends a Basic State response notification with the Pending Display Update bit is set to True.

  In step 10, the IUT returns the Queue Full error.

  In step 13, the IUT sends a Basic State response notification with the Pending Display Update bit set to False.

ESLS/SR/ECP/BV-09-C [Unassociate from AP]

- Test Purpose

  Verify that the Server IUT is unassociated from the access point after receiving the Unassociate from AP opcode.

- Reference

  [3] 3.9.2.2

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Unassociate from AP opcode (0x01) and ESL_ID set to the value in step 1.
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State opcode.
  4. The Upper Test verifies that the AP Sync Key is empty.
  5. The Lower Tester changes its Bluetooth address and initiates a connection request using a random key.

- Expected Outcome

  Pass verdict

  The IUT deletes the AP Sync Key and requests to start the Bonding procedure.

ESLS/SR/ECP/BV-10-C [Read Sensor Data]

- Test Purpose

  Verify that the Server IUT responds to setting the Read Sensor Data opcode and sends a Sensor Value ESL response.

- Reference

  [3] 3.9.2.6

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Characteristic Value Read procedure for the Sensor Information characteristic.
  3. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Read Sensor Data opcode (0x10) and:
     - ESL_ID set to the value in step 1
     - Sensor_Index set to one less than the number of Sensor Information Structures returned in step 2
  4. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Sensor Value opcode.
  5. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Read Sensor Data opcode (0x10) and:
     - ESL_ID set to the value in step 1
     - Sensor_Index set to 0
  6. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Sensor Value opcode.

- Expected Outcome

  Pass verdict

  In steps 4 and 6, the IUT sends a Sensor Value ESL response with valid parameter values for the requested sensor.

ESLS/SR/ECP/BV-11-C [Refresh Display]

- Test Purpose

  Verify that the Server IUT refreshes the indexed display when receiving the Refresh Display opcode from the Lower Tester.

- Reference

  [3] 3.9.2.7

- Initial Condition
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - Each display is not displaying an image.
  - The IUT has a preloaded image in the image storage location with the Image_Index value equal to Max_Image_Index.
- Test Procedure
  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Characteristic Value Read procedure for the Display Information characteristic.
  3. The Lower Tester executes the GATT Characteristic Value Read procedure for the Image Information characteristic.
  4. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Refresh Display opcode (0x11) and:
     - ESL_ID set to the value in step 1
     - Display_Index set to one less than the number of Display Data elements returned in step 2
  5. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Error opcode with a valid error code.
  6. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Display Image opcode (0x20) and:
     - ESL_ID set to the value in step 1
     - Display_Index set to one less than the number of Display Data Structures returned in step 2
     - Image_Index set to Max_Image_index returned in step 3
  7. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Display State opcode with Display_Index and Image_Index set to the values from step 6.
  8. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Refresh Display opcode (0x11) and:
     - ESL_ID set to the value in step 1
     - Display_Index set to one less than the number of Display Data elements returned in step 2
  9. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Display State opcode with Display_Index and Image_Index set to the values from step 6.
- Expected Outcome

  Pass verdict

  In step 5, the IUT sends a GATT Notification with the Error opcode and a valid error code.

  In step 8, the IUT refreshes the indexed display and sends a notification to the Lower Tester with the Display State opcode.

In step 9, the IUT sends a GATT Notification for the Display State opcode with Display_Image and Image_Index set to the values from step 6.

ESLS/SR/ECP/BV-12-C [Factory Reset]

- Test Purpose

  Verify that the Server IUT unassociates from the AP and resets to its original state before association with the AP when receiving the Factory Reset opcode from the Lower Tester.

- Reference

  [3] 3.9.2.4

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Factory Reset opcode (0x02) and:
     - ESL_ID set to the value in step 1
  3. Immediately after step 2, the Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00).
  4. The IUT may send a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Error opcode with error code set to Unspecified Error (0x01).
  5. The IUT disconnects the Bearer connection with the Lower Tester.
  6. The Lower Tester initiates a Connection Request using a random key.
  7. The Lower Tester starts the Bonding procedure, and the IUT and the Lower Tester exchange keys.

- Expected Outcome

  Pass verdict

  The IUT unassociates from the AP and reverts to its original state before association with the AP.

  In step 5, the IUT disconnects with the Lower Tester.

  In step 7, the Lower Tester requests to start the Bonding procedure, and keys are exchanged.

ESLS/SR/ECP/BV-13-C [Service Reset]

- Test Purpose

  Verify that the Server IUT resets the Service Needed bit of the Basic State response when receiving a Service Reset procedure from the Lower Tester.

- Reference

  [3] 3.9.2.3

- Initial Condition
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - A condition that requires the Service Needed bit is defined by the TSPX_condition_service_required IXIT value.
- Test Procedure
  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Upper Tester applies the TSPX_condition_service_required to establish a condition that requires the Service Needed bit.
  3. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00).
  4. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State opcode with the Service Needed bit set to 0b1.
  5. The Upper Tester removes the condition that was applied in step 1 so that the condition that required the Service Needed bit is no longer active.
  6. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Service Reset opcode (0x02).
  7. The IUT sends a GATT Characteristic Value Notification for the ESL Control Point to the Lower Tester with the Basic State opcode and the Service Needed bit set to 0b0.
  8. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00).
  9. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State opcode with the Service Needed bit set to 0b0.
- Expected Outcome

  Pass verdict

  In step 9, the IUT returns the condition of the Service Needed bit.

4.5.3 Timed Control Point Commands, Replace Queued Command

- Test Purpose

  Verify that the Server IUT properly replaces a Timed Control Point command with an absolute time that is the same as a queued command.
- Initial Condition
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
- Test Case Configuration

TCID	Reference [3]	Command/ Response	Parameters	
			Step 1	Step 3
ESLS/SR/ECP/BV-14-C [Timed Control Point Commands, Replace Queued Command, LED Timed Control]	3.9.2.11.1	LED Timed Control LED State	LED_Index = 0 Color_Red = 0b11 Color_Green = 0b00 Color Blue = 0b00	LED_Index = 0 Color_Red = 0b00 Color_Green = 0b00 Color Blue = 0b11

TCID	Reference [3]	Command/ Response	Parameters	
			Step 1	Step 3
ESLS/SR/ECP/BV-15-C [Timed Control Point Commands, Replace Queued Command, Display Timed Image]	3.9.2.9.1	Display Timed Image Display State	Display_Index = 0 Image_Index = 0x00	Display_Index = 0 Image_Index = 0x01

Table 4.8: Timed Control Point Commands, Replace Queued Command test cases

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode and Parameters set to the value specified in Table 4.8 and Absolute_Time set to a random value at least 30 seconds in the future.
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the response specified in Table 4.8.
  4. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode and Parameters set to the value specified in Table 4.8 and Absolute_Time set to the same value in step 2.
  5. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the response specified in Table 4.8.
  6. At the Absolute Time specified in step 2, the Upper Tester verifies that the IUT executes the parameters from step 4.

- Expected Outcome

  Pass verdict

  In step 6, the IUT executes the parameters from step 4.

4.5.4 Control Point Error Response

- Test Purpose

  Verify that the Server IUT properly returns an Error response when the IUT does not have the capability for the Control Point opcode sent by the Lower Tester.

- Reference

  [3] 3.9.2

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - The IUT is not transmitting connectable advertising.

- Test Case Configuration

TCID	Control Point Opcode
ESLS/SR/ECP/BI-01-C [Control Point Error Response, LED Control]	LED Control
ESLS/SR/ECP/BI-02-C [Control Point Error Response, LED Timed Control]	LED Timed Control
ESLS/SR/ECP/BI-03-C [Control Point Error Response, Display Image]	Display Image
ESLS/SR/ECP/BI-04-C [Control Point Error Response, Display Time Image]	Display Time Image
ESLS/SR/ECP/BI-05-C [Control Point Error Response, Read Sensor Data]	Read Sensor Data
ESLS/SR/ECP/BI-06-C [Control Point Error Response, Refresh Display]	Refresh Display
ESLS/SR/ECP/BI-07-C [Control Point Error Response, Vendor-specific Tag]	Vendor-specific Tag

Table 4.9: Ignore Unsupported Opcode Test Cases

- Test Procedure

1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode set to the value from Table 4.9.
3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Error opcode.

- Expected Outcome

Pass verdict

In step 3, the IUT returns an Error opcode.

4.5.5 Control Point, Invalid Index

- Test Purpose

Verify that the Server IUT properly returns an Error response when the IUT receives a control point command for a capability with an invalid index.

- Reference

[3] 3.9.2

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - The IUT is not transmitting connectable advertising.

- Test Case Configuration

TCID	Control Point Opcode	Characteristic(s)
ESLS/SR/ECP/BI-08-C [Control Point Invalid Index, Sensor Data]	Read Sensor Data	Sensor Information
ESLS/SR/ECP/BI-09-C [Control Point Invalid Index, Refresh Display]	Refresh Display	Display Information

TCID	Control Point Opcode	Characteristic(s)
ESLS/SR/ECP/BI-10-C [Control Point Error Response, LED Control]	LED Control	LED Information
ESLS/SR/ECP/BI-11-C [Control Point Error Response, LED Timed Control]	LED Timed Control	LED Information

Table 4.10: Control Point, Invalid Index test cases

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Characteristic Value Read procedure for the characteristic specified in Table 4.10. The number of array elements returned is stored for future use.
  3. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode set to the value from Table 4.10 and:
     - ESL_ID set to the value in step 1
     - Index set to one more than the value stored in step 2
  4. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Invalid Parameter(s) (0x06) error.

- Expected Outcome

  Pass verdict

  In step 4, the IUT returns a 0x06 error.

4.5.6 Control Point, Invalid Index, Display Commands

- Test Purpose

  Verify that the Server IUT properly returns an Error response when the IUT receives a display control point command for a device with an invalid index.

- Reference

  [3] 3.9.2

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.
  - The IUT is not transmitting connectable advertising.

- Test Case Configuration

TCID	Control Point Opcode
ESLS/SR/ECP/BI-12-C [Control Point Invalid Index, Display Image]	Display Image
ESLS/SR/ECP/BI-13-C [Control Point Error Response, Display Time Image]	Display Time Image

Table 4.11: Control Point, Invalid Index, Display Commands test cases

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Characteristic Value Read procedure for the Display Information characteristic. The number of array elements returned is stored for future use.
  3. The Lower Tester executes the GATT Characteristic Value Read procedure for the Image Information characteristic. The Max_Image_Index value is stored for future use.
  4. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode set to the value from Table 4.11 and:
     - ESL_ID set to the value in step 1
     - Display_Index set to one more than the value stored in step 2
     - Image_Index set to 0
  5. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Invalid Parameter(s) (0x06) error.
  6. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode set to the value from Table 4.11 and:
     - ESL_ID set to the value in step 1
     - Display_Index set to 0
     - Image_Index set to one more than the value stored in step 3
  7. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Invalid Parameter(s) (0x06) error.

- Expected Outcome

  Pass verdict

  In steps 5 and 7, the IUT returns a 0x06 error.

ESLS/SR/ECP/BI-14-C [Reject Command with Invalid ESL ID]

- Test Purpose

  Verify that the Server IUT rejects an incoming ESL Control Point procedure with an incorrect ESL ID.

- Reference

  [3] 3.9.2

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the ESL Address characteristic with ESL_ID set to 0b01010101 and Group_ID set to the same value as in step 1.
  3. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00) with ESL_ID set to 0b01010100 and Group_ID set to the same value as in step 1.

4. The IUT sends an ESL Error response to the Lower Tester with the error code Invalid Parameter(s) (0x06).

- Expected Outcome

  Pass verdict

  In step 4, the IUT responds with the 0x06 (Invalid Parameters) ESL Error response.

ESLS/SR/ECP/BV-16-C [LED Control, Replace Active Command]

- Test Purpose

  Verify that the Server IUT properly replaces an existing LED Control active command with a new command.

- Reference

  [3] 3.9.2.10

- Initial Condition

  - The index of a monochrome LED is defined by the TSPX_monochrome_led_index IXIT value.
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Control opcode (0xB0) and:
     - ESL_ID set to the value from step 1
     - LED_Index set to 0
     - Color_Red, Color_Green, and Color_Blue set to 0b11
     - Brightness set to 0b11
     - Flashing_Pattern set to Pattern: 0x0000001041, Bit_Off_Period: 0x32 (100 ms), Bit_On_Period: 0xFA (500 ms)
     - Repeat_Type set to 0b0
     - Repeats_Duration set to 0x7FFF
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to 0.
  4. The Upper Tester verifies that the LED blinks with the LED On time being 500 ms and the LED Off time being 500 ms.
  5. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Control opcode (0xB0) and:
     - ESL_ID set to the value from step 1
     - LED_Index set to 0
     - Color_Red, Color_Green, and Color_Blue set to 0b11
     - Brightness set to 0b11
     - Flashing_Pattern set to Pattern: 0xAAAAAAAAAA, Bit_Off_Period: 0x7D (250 ms), Bit_On_Period: 0x7D (250 ms)
     - Repeat_Type set to 0b0
     - Repeats_Duration set to 0x7FFF

6. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to 0.
7. The Upper Tester verifies that the LED blinks with the LED On time being 250 ms and the LED Off time being 250 ms.

- Expected Outcome

  Pass verdict

  After step 6, the IUT changes from blinking once a second to twice a second.

ESLS/SR/ECP/BV-17-C [LED Timed Control, Replace Active Command]

- Test Purpose

  Verify that the Server IUT properly replaces an existing LED Timed Control active command with a new command.

- Reference

  [3] 3.9.2.11

- Initial Condition

  - The index of a monochrome LED is defined by the TSPX_monochrome_led_index IXIT value.
  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
2. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Current Absolute Time characteristic set to 10000 ms.
3. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Timed Control opcode (0xF0) and:
   - ESL_ID set to the value from step 1
   - LED_Index set to 0
   - Color_Red set to 0b00
   - Color_Green set to 0b00
   - Color_Blue set to 0b00
   - Brightness set to 0b11
   - Flashing_Pattern set to Pattern: 0x0000001041, Bit_Off_Period: 0x32 (100 ms), Bit_On_Period: 0xFA (500 ms)
   - Repeat_Type set to 0b0
   - Repeats_Duration set to 0x7FFF
   - Absolute_Time set to 15000
4. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to 0.
5. 6 seconds after step 3, the Upper Tester verifies that the LED blinks with the LED On time being 500 ms and the LED Off time being 500 ms.

6. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Timed Control opcode (0xB0) and:
    - ESL_ID set to the value from step 1
    - LED_Index set to 0
    - Color_Red set to 0b00
    - Color_Green set to 0b00
    - Color_Blue set to 0b00
    - Brightness set to 0b11
    - Flashing_Pattern set to Pattern: 0xAAAAAAAAAA, Bit_Off_Period: 0x7D (250 ms), Bit_On_Period: 0x7D (250 ms)
    - Repeat_Type set to 0b0
    - Repeats_Duration set to 0x7FFF
    - Absolute_Time set to 26000
7. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to 0.
8. 6 seconds after step 6, the Upper Tester verifies that the LED blinks with the LED On time being 250 ms and the LED Off time being 250 ms.

- Expected Outcome

  Pass verdict

  After step 7, the IUT changes from blinking once a second to twice a second.

4.5.7 Timed Control Point Commands, Invalid Absolute Time Parameter

- Test Purpose

  Verify that the Server IUT properly returns an Implausible Absolute Time error when calling the Timed Control Point commands with an Absolute Time parameter that is more than 48 days in the future.

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Case Configuration

TCID	Reference [3]	Command
ESLS/SR/ECP/BI-15-C [Timed Control Point Commands, Invalid Absolute Time Parameter, LED Timed Control]	3.9.2.11.1	LED Timed Control
ESLS/SR/ECP/BI-16-C [Timed Control Point Commands, Invalid Absolute Time Parameter, Display Timed Image]	3.9.2.9.1	Display Timed Image

Table 4.12: Timed Control Point Commands, Invalid Absolute Time Parameter test cases

- Test Procedure

1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
2. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Current Absolute Time characteristic with a value of 123.

3. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode specified in Table 4.12 and Absolute_Time set to 4150800123.
4. The IUT sends an ATT Error response to the Lower Tester with the error code Implausible Absolute Time (0x0C).

- Expected Outcome

  Pass verdict

  In step 4, the IUT responds with the 0x0C.

4.5.8 Timed Control Point Commands, Absolute Time set to 0

- Test Purpose

  Verify that the Server IUT properly deletes a queued Timed Control Point command when the Timed Control Point command is called again when the Absolute_Time parameter is set to 0.

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Case Configuration

TCID	Reference [3]	Command/ Response/ Pending Update	Parameters	
			Step 1	Step 3
ESLS/SR/ECP/BV-18-C [Timed Control Point Commands, Absolute Time set to 0, LED Timed Control]	3.9.2.11.1	LED Timed Control LED State Pending LED Update	LED_Index = 0 Color_Red = 0b11 Color_Green = 0b00 Color Blue = 0b00	LED_Index = 0 Color_Red = 0b00 Color_Green = 0b00 Color Blue = 0b11
ESLS/SR/ECP/BV-19-C [Timed Control Point Commands, Absolute Time set to 0, Display Timed Image]	3.9.2.9.1	Display Timed Image Display State Pending Display Update	Display_Index = 0 Image_Index = 0x00	Display_Index = 0 Image_Index = 0x01

Table 4.13: Timed Control Point Commands, Absolute Time set to 0 test cases

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode and Parameters set to the value specified in Table 4.13 and Absolute_Time set to a random value between 15 and 30 seconds in the future.
  3. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the response specified in Table 4.13.
  4. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00) and ESL_ID set to the value in step 1.

5. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State response with the Pending Update bit specified in Table 4.13 set to True.
6. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Control Point opcode and Parameters set to the value specified in Table 4.13 and Absolute_Time set to 0.
7. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the response specified in Table 4.13.
8. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Ping opcode (0x00) and ESL_ID set to the value in step 1.
9. The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Basic State response with the Pending Update bit specified in Table 4.13 set to False.
10. 30 seconds later, the Upper Tester confirms that the Timed command in step 2 is not executed.

- Expected Outcome

  Pass verdict

  The IUT does not execute the command in step 2.

  In step 5, the IUT sends the Basic State response with the Pending Update bit set to True.

  In step 9, the IUT sends the Basic State response with the Pending Update bit set to False.

ESLS/SR/ECP/BV-20-C [Update Complete]

- Test Purpose

  Verify that the Server IUT synchronizes with the access point and disconnects the ACL with the access point.

- Reference

  [3] 3.9.2.5

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Update Complete opcode (0x04) and ESL_ID set to the value in step 1.
  3. The IUT synchronizes with the Lower Tester and receives PAwR synchronization packets.
  4. The IUT disconnects the ACL connection with the Lower Tester.

- Expected Outcome

  Pass verdict

  In step 3, the IUT synchronizes with the Lower Tester.

  In step 4, the IUT disconnects from the Lower Tester.

4.5.9 Timed Control Point Command Per Element

- Test Purpose

  Verify that the Server IUT has one Timed Control command per element. The IUT has one LED Timed Control command per LED element and one Display Timed Image command per display.

- Initial Condition

  - Enable the IUT for use with the ESL Control Point by performing the preamble described in Section 4.2.3.

- Test Case Configuration

TCID	Reference	Characteristic
ESLS/SR/ECP/BV-21-C [Timed Control Point Command Per Element, LED]	[3] 3.9.2.11	LED Information characteristic
ESLS/SR/ECP/BV-22-C [Timed Control Point Command Per Element, Display]	[3] 3.9.2.9	Display Information characteristic

Table 4.14: Timed Control Point Command Per Element test cases

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Address characteristic with a valid ESL_ID and Group_ID.
  2. The Lower Tester executes the GATT Characteristic Value Read procedure for the characteristic specified in Table 4.14. The number of array elements returned is stored for future use.
  3. The Lower Tester executes the GATT Write Characteristic Value sub-procedure for the ESL Current Absolute Time characteristic set to 10000 ms.

  Repeat steps 2–4 for the number of elements in step 2:

  4. Perform alternative 4A or 4B depending on the Timed Control Point.
     Alternative 4A (LED Timed Control Point):
     - 4A.1 The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the LED Timed Control opcode (0xF0) and:
       - ESL_ID set to the value in step 1
       - LED_Index set to Element Index
       - Color_Red, Color_Green, and Color_Blue set to 0b00
       - Brightness set to 1
       - Flashing_Pattern set to: Pattern = 0xFFFFFFFFFF, Bit_Off_Period: 0xFA (500 ms), Bit_On_Period: 0xFA (500 ms)
       - Repeat_Type set to 0b1
       - Repeats_Duration set to 0x0
       - Absolute_Time set to a random time within 120 seconds in the future and not within 5 seconds from any other round
     - 4A.2 The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the LED State opcode with LED_Index set to the value in step 4A.1.

Alternative 4B (Display Timed Image Control Point):

4B.1 The Lower Tester executes the GATT Write Without Response sub-procedure or GATT Write Characteristic Value sub-procedure for the ESL Control Point with the Display Timed Image opcode (0x60) and:
- ESL_ID set to the value from step 1
- Display_Index set to Element Index
- Image_Index set to 0
- Absolute_Time set to a random time within 120 seconds in the future and not within 5 seconds from any other round

4B.2 The IUT sends a GATT Characteristic Value Notification to the Lower Tester for the ESL Control Point with the Display State opcode.

5. For the next 120 seconds, the Upper Tester confirms that each Element Index changes at the Absolute_Time set in step 4A.1 or 4B.1.

- Expected Outcome

  Pass verdict

  Each LED or each display is enabled at different times within 120 seconds.

4.6 Updating state

ESLS/SR/UPD/BV-01-C [Ignore Periodic Advertising with Responses data]

- Test Purpose

  Verify that the Server IUT in the Updating State ignores all Periodic Advertising with Responses PDUs.

- Reference

  [3] 2.7.3.4

- Initial Condition

  - The IUT has an active ATT or EATT Bearer connection with the Lower Tester.
  - The IUT is in the Updating State using the preamble in Section 4.2.4.

- Test Procedure

  1. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the ESL Address characteristic with an ESL_ID and Group_ID set to 3.
  2. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the AP Synchronization Key characteristic with an AP Synchronization Key.
  3. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the ESL Response Key characteristic with an ESL Response Key.
  4. The Lower Tester executes the GATT Write Characteristic Value sub-procedure to the IUT for the ESL Current Absolute Time Characteristic with a current time.
  5. The Lower Tester disconnects the active connection.
  6. The Lower Tester initiates a connection with the IUT.
  7. The Lower Tester sends a PAwR synchronization packet in the third slot with the Factory Reset opcode.
  8. The IUT is not returned to the factory state.
  9. The Lower Tester disconnects the active connection.

10. If the IUT has at least one display, then execute the following:
    - 10.A The Lower Tester sends a PAwR synchronization packet in the third slot with the Display Information opcode.
    - 10.B The IUT responds to step 10.A with a Display State response.
11. If the IUT has at least one LED, then execute the following:
    - 11.A The Lower Tester sends a PAwR synchronization packet in the third slot with the LED State response.
    - 11.B The IUT responds to step 11.A with an LED State response.

- Expected Outcome

  Pass verdict

  In step 9, the IUT does not return to the factory state.

  In step 10.B, the IUT responds with a Display State response.

  In step 11.B, the IUT responds with an LED State response.

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 Electronic Shelf Label Service [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)
ESLS 2/2	Service GGIT, Electronic Shelf Label	ESLS/SR/SGGIT/SER/BV-01-C ESLS/SR/UPD/BV-01-C
ESLS 3/1	ESL Address Characteristic	ESLS/SR/SGGIT/CHA/BV-01-C ESLS/SR/CHA/BI-01-C
ESLS 3/2	AP Sync Key Characteristic	ESLS/SR/SGGIT/CHA/BV-02-C
ESLS 3/3	ESL Response Key Characteristic	ESLS/SR/SGGIT/CHA/BV-03-C
ESLS 3/4	ESL Current Absolute Time Characteristic	ESLS/SR/SGGIT/CHA/BV-04-C ESLS/SR/CHA/BV-01-C
ESLS 3/5	Display Information Characteristic	ESLS/SR/SGGIT/CHA/BV-05-C ESLS/SR/CHA/BV-02-C
ESLS 3/5 AND ESLS 3/10	Display Information Characteristic, One Display	ESLS/SR/CHA/BV-05-C
ESLS 3/6	Image Information Characteristic	ESLS/SR/SGGIT/CHA/BV-06-C
ESLS 3/7	Sensor Information Characteristic	ESLS/SR/SGGIT/CHA/BV-07-C ESLS/SR/CHA/BV-03-C
ESLS 3/7 AND ESLS 3/14	Sensor Information Characteristic, One Sensor	ESLS/SR/CHA/BV-06-C
ESLS 3/8	LED Information Characteristic	ESLS/SR/SGGIT/CHA/BV-08-C ESLS/SR/CHA/BV-04-C
ESLS 3/8 AND ESLS 3/12	LED Information Characteristic, One LED	ESLS/SR/CHA/BV-07-C
ESLS 3/9	ESL Control Point Characteristic	ESLS/SR/SGGIT/CHA/BV-09-C
ESLS 4/1	Ping	ESLS/SR/ECP/BV-01-C ESLS/SR/ECP/BI-14-C
ESLS 4/2 AND ESLS 3/19	LED Control, Color	ESLS/SR/ECP/BV-02-C

Item	Feature	Test Case(s)
ESLS 4/2 AND ESLS 3/12 AND ESLS 3/18	LED Control, Monochrome	ESLS/SR/ECP/BV-03-C ESLS/SR/ECP/BV-04-C
ESLS 4/2 AND (ESLS 3/12 OR ESLS 3/13)	LED Control	ESLS/SR/ECP/BV-05-C ESLS/SR/ECP/BV-16-C ESLS/SR/ECP/BI-10-C
ESLS 4/3 AND (ESLS 3/12 OR ESLS 3/13)	LED Timed Control	ESLS/SR/ECP/BV-06-C ESLS/SR/ECP/BV-17-C ESLS/SR/ECP/BV-18-C ESLS/SR/ECP/BI-11-C ESLS/SR/ECP/BI-15-C
ESLS 4/3 AND ESLS 3/13	LED Timed Control, More Than One LED	ESLS/SR/ECP/BV-21-C
ESLS 4/3 AND (ESLS 3/12 OR ESLS 3/13) AND ESLS 3/17	LED Timed Control, Color	ESLS/SR/ECP/BV-14-C
ESLS 4/4 AND (ESLS 3/10 OR ESLS 3/11)	Display Image	ESLS/SR/ECP/BV-07-C ESLS/SR/ECP/BI-12-C
ESLS 4/5 AND (ESLS 3/10 OR ESLS 3/11)	Display Timed Image	ESLS/SR/ECP/BV-08-C ESLS/SR/ECP/BV-15-C ESLS/SR/ECP/BV-19-C ESLS/SR/ECP/BI-13-C ESLS/SR/ECP/BI-16-C
ESLS 4/5 AND ESLS 3/11	Display Timed Image, More Than One Display	ESLS/SR/ECP/BV-22-C
ESLS 4/6	Unassociate from AP	ESLS/SR/ECP/BV-09-C
ESLS 4/7 AND (ESLS 3/14 OR ESLS 3/15)	Read Sensor Data	ESLS/SR/ECP/BV-10-C ESLS/SR/ECP/BI-08-C
ESLS 4/8 AND (ESLS 3/10 OR ESLS 3/11)	Refresh Display	ESLS/SR/ECP/BV-11-C ESLS/SR/ECP/BI-09-C
ESLS 4/9	Factory Reset	ESLS/SR/ECP/BV-12-C
ESLS 4/11	Service Reset	ESLS/SR/ECP/BV-13-C
ESLS 4/10	Vendor-specific Tag	ESLS/SR/ECP/BI-07-C
ESLS 4/2 AND NOT ESLS 3/12 AND NOT ESLS 3/13	LED Control, No LED Support	ESLS/SR/ECP/BI-01-C
ESLS 4/3 AND NOT ESLS 3/12 AND NOT ESLS 3/13	LED Timed Control, No LED Support	ESLS/SR/ECP/BI-02-C
ESLS 4/4 AND NOT ESLS 3/10 AND NOT ESLS 3/11	Display Image, No Display Support	ESLS/SR/ECP/BI-03-C

Item	Feature	Test Case(s)
ESLS 4/5 AND NOT ESLS 3/10 AND NOT ESLS 3/11	Display Timed Image, No Display Support	ESLS/SR/ECP/BI-04-C
ESLS 4/7 AND NOT ESLS 3/14 AND NOT ESLS 3/15	Read Sensor Data, No Sensor Support	ESLS/SR/ECP/BI-05-C
ESLS 4/8 AND NOT ESLS 3/10 AND NOT ESLS 3/11	Refresh Display, No Display Support	ESLS/SR/ECP/BI-06-C
ESLS 4/12	Update Complete	ESLS/SR/ECP/BV-20-C

Table 5.1: Test case mapping

6 Revision history and acknowledgments

Revision History

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