

# Automation IO Service (AIOS)

## **Bluetooth® Test Suite**

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- **Revision:** AIOS.TS.1.0.1 edition 2
- **Revision Date:** 2019-11-11
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# 1 Scope

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

The objective of this test suite is to provide a basis for interoperability for Bluetooth devices giving a high probability of air interface interoperability between different manufacturers' Bluetooth devices.

## 2 References, Definitions, and Abbreviations

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### 2.1 References

This Bluetooth document incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. Additional definitions and abbreviations can be found in [1] and [2].

- [1] Test Strategy and Terminology Overview
- [2] Bluetooth Core Specification, Version 4.0 or later
- [3] Automation IO Service Specification v1.0
- [4] Automation IO Service ICS, AIOS.ICS
- [5] GATT Test Suite GATT.TS
- [6] Automation IO Profile Specification v1.0
- [7] Automation IO Service Implementation extra Information for Test, IXIT
- [8] Characteristic and Descriptor descriptions are accessible via the [Bluetooth SIG Assigned Numbers](#)

### 3 Test Suite Structure (TSS)

#### 3.1 Overview

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

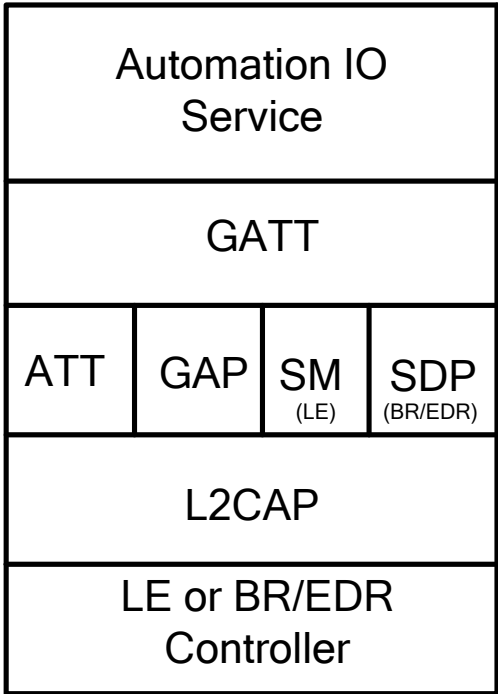


Figure 3.1: Automation IO Service Test Model

#### 3.2 Test Strategy

The test objectives are to verify functionality of the Automation IO Service within a Bluetooth Host and enable interoperability between Bluetooth Hosts on different devices. The testing approach is to cover mandatory and optional requirements in the service specification and to match these to the support of the IUT as described in the ICS Proforma [4].

The test equipment shall provide an implementation of the Radio Controller and the parts of the Host needed to perform the test cases defined in the Automation IO Service Test Suite. For some test cases, it is necessary to stimulate the IUT from an Upper Tester. In practice, this could be implemented as a special test interface, an MMI, or another interface supported by the IUT.

The Automation IO 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 Cases.

The interface between the IUT and the Upper Tester may be

- a man-machine interface
- provided by the IUT manufacturer



## 3.3 Test Groups

The following test groups have been defined:

### 3.3.1 Service Definition

Verify the service definition.

### 3.3.2 Characteristic Declaration

Verify the presence and contents of characteristic declarations.

### 3.3.3 Characteristic Combinations

Verify that combinations of characteristics and combinations of property fields of the characteristic declarations.

### 3.3.4 Characteristic Descriptors

Verify the presence and contents of characteristic descriptors.

### 3.3.5 Characteristic Read

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

### 3.3.6 Characteristic Write and Write without Response

Verify characteristics which support writing can be written with or without response.

### 3.3.7 Configure Indication and Notification

Verify characteristics can be configured for indication or notification.

- Digital / Aggregate Notification
  - Verify compliant digital / aggregate operation in response to enable and disable characteristic notification.

### 3.3.8 Analog / Aggregate Notification

Verify compliant analog / aggregate operation in response to enable and disable characteristic notification.

- Digital / Aggregate Indication
  - Verify compliant digital / aggregate operation in response to enable and disable characteristic indication.
- Analog / Aggregate Indication
  - Verify compliant analog / aggregate operation in response to enable and disable characteristic indication.

## 4 Test Cases (TC)

### 4.1 Introduction

#### 4.1.1 Test Case Identification Conventions

Test cases shall be assigned unique identifiers per the conventions in [2]. The convention used here is **<spec abbreviation>/<IUT role>/<class>/<feat>/<func>/<subfunc>/<cap>/<xx>-<nn>-<y>**.

Bolded ID parts shall appear in the order prescribed. Non-bolded ID parts (if applicable) shall appear between the bolded parts. The order of the non-bolded parts may vary from test suite to test suite, but shall be consistent within each individual test suite.

Identifier Abbreviation	Spec Identifier <spec abbreviation>
AIOS	Automation IO Service
Identifier Abbreviation	Role Identifier <IUT role>
SR	Server role
Identifier Abbreviation	Feature Identifier <feat>
CI	Characteristic Indication
CN	Characteristic Notification
COM	Characteristics Combinations
CON	Configure Indication or Notification
CR	Characteristic Read
CW	Characteristic Write and Write without Response
DEC	Characteristic Declaration
DES	Characteristic Descriptors
SD	Service Definition

Table 4.1: AIOS TC Feature Naming Convention

#### 4.1.2 Conformance

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

The Bluetooth Qualification Program may employ tests to verify implementation robustness. The level of implementation robustness that is verified varies from one Specification to another and may be revised for cause based on interoperability issues found in the market.

Such tests may verify

- that claimed capabilities may be used in any order and any number of repetitions that is not excluded by the Specification, OR
- that capabilities enabled by the implementations are sustained over durations expected by the use case, OR
- that the implementation gracefully handles any quantity of data expected by the use case, OR
- that the implementation gracefully rejects any attempt to exercise capabilities which were declared as not supported. Graceful rejection means that the implementation demonstrates uninterrupted conformance to the specification immediately after rejecting such attempts without any need to be externally reset or adjusted, OR
- that in cases where more than one valid interpretation of the Specification exist, the implementation complies with at least one interpretation and gracefully handles other interpretations OR
- that the implementation is immune to attempted security exploits

A single execution of each of the required tests is required in order to constitute a pass verdict. However, it is noted that in order to provide a foundation for interoperability, it is necessary that a qualified implementation consistently and repeatedly pass any of the applicable tests.

In any case, where a member finds an issue with the Test Plan Generator, the Test Case as described in the Test Suite, or with the Test System utilized, the Member is required to notify the responsible party via an errata request such that the issue may be addressed.

### 4.1.3 Pass/Fail Verdict Conventions

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

The convention in this test suite is that, unless there is a specific set of fail conditions outlined in the test case, the IUT fails the test case as soon as one of the pass criteria conditions cannot be met. If this occurs, the outcome of the test shall be the Fail Verdict.

## 4.2 Setup Preambles

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

### 4.2.1 ATT Bearer on LE Transport

Follow the preamble procedure described in [5] Section 4.2.1.2 with the IUT operating in the Peripheral role.

### 4.2.2 ATT Bearer on BR/EDR Transport

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

## 4.3 Service Definition

Verify the service definition.

### 4.3.1 AIOS/SR/SD/BV-01-C [Service Definition over LE]

- Test Purpose

Verify that the IUT has an instantiation of the Automation IO Service as a primary service. This test case only applies when using the LE transport.

- Reference

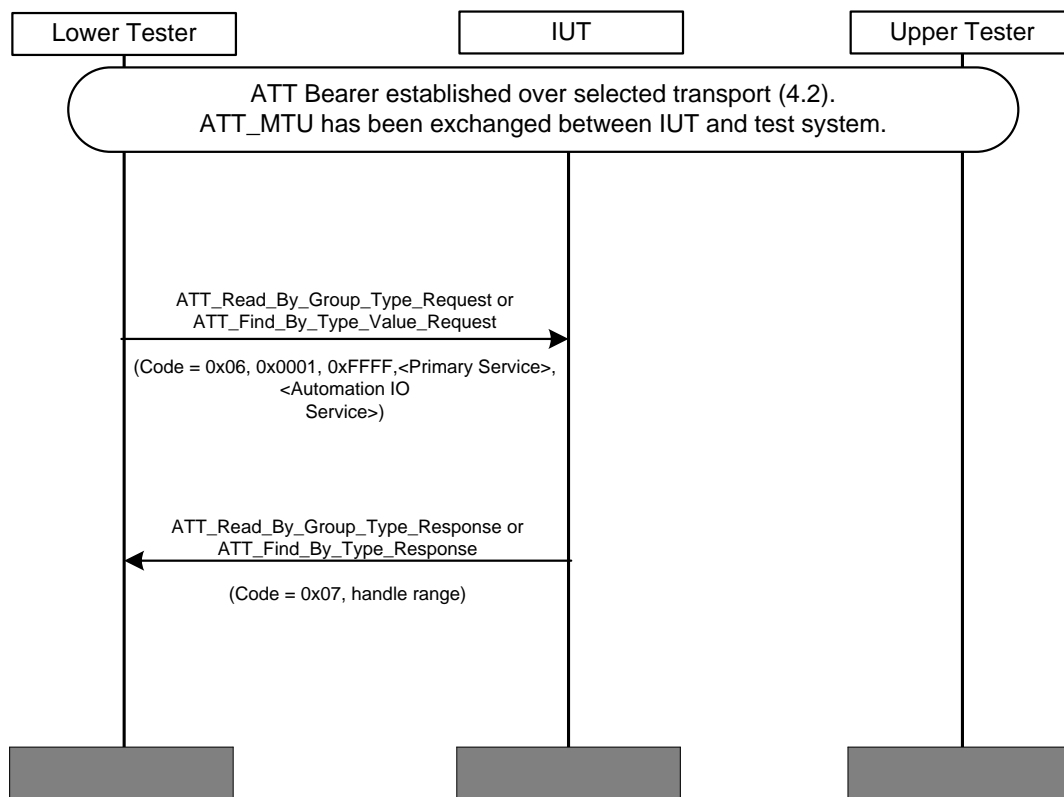
[3] 2

- Initial Condition

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in Section 4.2.1.

- Test Procedure

1. The Lower Tester sends either an *ATT\_Read\_By\_Group\_Type\_Request* (0x0001, 0xFFFF) with the Attribute Type parameter set to the UUID for «Primary Service» or an *ATT\_Find\_By\_Type\_Value\_Request* (0x0001, 0xFFFF) to the IUT, with Attribute Type parameter set to the UUID for «Primary Service» and Value set to «Automation IO Service».
2. Verify that one attribute handle range is returned, containing the starting handle and the ending handle of the service definition.



- Expected Outcome

Pass verdict

One attribute handle range is returned containing the starting handle and the ending handle of the Automation IO Service definition. The Attribute Type parameter is set to the UUID for «Primary Service».

#### 4.3.2 AIOS/SR/SD/BV-02-C [SDP Record]

- Test Purpose

Verify that the SDP Record for the Automation IO Service is found and contains the correct information. This test case only applies when using the BR/EDR transport.

- Reference

[3] 4

- Initial Condition

An ACL connection over BR/EDR is established between the Lower Tester and IUT as defined in Section 4.2.2

- Test Procedure

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

- Expected Outcome

Pass verdict

The SDP record for the Automation IO Service is found.

All attributes which are mandatory for the Automation IO Service are present in the SDP record.

The values of all attributes in the SDP record meet the requirements of the Automation IO Service.

The GATT Start Handle and GATT End Handle parameters in the SDP record match the start handle and end handle of the Automation IO Service.

## 4.4 Characteristic Declaration

- Test Purpose

This test group contains test cases to verify that the characteristic property field of the characteristic declaration meets the requirements of the service. The verification is performed one characteristic at a time, as enumerated in the test cases in Table 4.2, using this generic test procedure.

- Reference

[3] 3

- Initial Condition

The handle range of the Automation IO Service has been previously discovered by the Lower Tester in test case [AIOS/SR/SD/BV-01-C \[Service Definition over LE\]](#) or [AIOS/SR/SD/BV-02-C \[SDP Record\]](#).

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in Section [4.2.1](#) if using an LE transport or Section [4.2.2](#) if using a BR/EDR transport.

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.2](#):

1. Discover all characteristics of the Automation IO Service by executing the test procedure of GATT test case GATT/SR/GAD/BV-04-C and/or GATT/SR/GAD/BV-05-C in [\[5\]](#).
2. For a discovered characteristic that is listed in [Table 4.2](#), verify that the characteristic properties field of the characteristic declaration meets the requirements of the Automation IO Service.

- Expected Outcome

The following verdicts apply to the test cases listed in [Table 4.2](#).

Pass verdict

The characteristic is discovered and the characteristic properties field of the characteristic declaration meets the requirements of the Automation IO Service.

#### Characteristic Declaration Test Cases

Test Case	Characteristic Properties Bitmap (Requirements)
<b>4.4.1</b> <a href="#">AIOS/SR/DEC/BV-01-C [Characteristic Declaration – Digital]</a>	Bitmap value for Read, Write, Write without response, Indicate and Notify is 0x02, 0x04, 0x06, 0x08, 0x0A, 0x0C, 0x12, 0x16, 0x1A, 0x1E, 0x22, 0x26, 0x2A, 0x2E, 0x82, 0x84, 0x86, 0x88, 0x8A, 0x8C, 0x92, 0x96, 0x9A , 0x9E, 0xA2, 0xA6,0xAA or 0xAE.  <a href="#">([3] Table 3.1)</a>
<b>4.4.2</b> <a href="#">AIOS/SR/DEC/BV-02-C [Characteristic Declaration –Analog]</a>	Bitmap value for Read, Write, Write without response, Indicate and Notify is 0x02, 0x04, 0x06, 0x08, 0x0A, 0x0C, 0x12, 0x16, 0x1A, 0x1E, 0x22, 0x26, 0x2A, 0x2E, 0x82, 0x84, 0x86, 0x88, 0x8A 0x8C , 0x92, 0x96, 0x9A , 0x9E, 0xA2, 0xA6,0xAA or 0xAE.  <a href="#">([3] Table 3.1)</a>

Test Case	Characteristic Properties Bitmap (Requirements)
<b>4.4.3</b> <b>AIOS/SR/DEC/BV-03-C [Characteristic Declaration – Aggregate]</b>	Bitmap value for Read, Indicate and Notify is 0x02, 0x12, 0x22, 0x82, 0x92 or 0xA2 ([3] Table 3.1)

Table 4.2: Characteristic Declaration Test Cases

## 4.5 Characteristic Combinations

- Test Purpose

This test group contains test cases to verify that combinations of characteristics and combinations of property fields of the characteristic declarations meets the requirements of the service.

- Reference

[3] 3

- Initial Condition

The handle range of the Automation IO Service has been previously discovered by the Lower Tester in test case [AIOS/SR/SD/BV-01-C \[Service Definition over LE\]](#) or [AIOS/SR/SD/BV-02-C \[SDP Record\]](#).

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in Section [4.2.1](#) if using an LE transport or Section [4.2.2](#) if using a BR/EDR transport.

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.3](#):

1. Discover all characteristics of the Automation IO Service by executing the test procedure of GATT test case [GATT/SR/GAD/BV-04-C](#) and [GATT/SR/GAD/BV-05-C](#) in [\[5\]](#).
2. For the discovered characteristics verify the requirements that is listed in [Table 4.3](#).

- Expected Outcome

The following verdicts apply to the test cases listed in [Table 4.3](#).

Pass verdict

See [Table 4.3](#).

### Characteristic Combination Test Cases

Test Case	Requirements
<b>4.5.1</b> <b>AIOS/SR/COM/BV-01-C [Verify minimum configuration]</b>	Verify that at least one Digital or Analog Characteristic is used ([3] 3).

Test Case	Requirements
<b>4.5.2</b> <b>AIOS/SR/COM/BV-02-C [Verify number of Aggregate]</b>	The IUT has executed and passed Test Case <a href="#">AIOS/SR/COM/BV-01-C [Verify minimum configuration]</a> . Verify that no more than one Aggregate characteristic exists ([3] 3).
<b>4.5.3</b> <b>AIOS/SR/COM/BV-03-C [Verify valid Digital, Analog and Aggregate combinations]</b>	The IUT has executed and passed Test Case <a href="#">AIOS/SR/COM/BV-01-C [Verify minimum configuration]</a> . If an Aggregate Characteristic exists, verify that Digital or Analog characteristics exists with Characteristic Properties bitmap with a value of 0x02, 0x06, 0x0A, 0x0E, 0x82, 0x86, 0x8A, or 0x8E([3] 3).

Table 4.3: Characteristic Combination Test Cases

## 4.6 Characteristic Descriptors

- Test Purpose

This test group contains test cases to verify that the characteristic descriptors meet the requirements of the Automation IO Service. The verification is done one descriptor at a time, as enumerated in the test cases in [Table 4.4](#), using this generic test procedure.

- Reference

[\[3\] 3](#)

- Initial Condition

The handle range of each characteristic referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in [Section 4.3.2](#) or is known to the Lower Tester by other means.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.4](#):

1. Discover all characteristic descriptors of the characteristic by executing the test procedure of GATT test case GATT/SR/GAD/BV-06-C in [\[5\]](#) using the handle range of the characteristic. The IUT returns at least one handle-UUID pair.
2. If the UUID in a handle-UUID pair is for a characteristic descriptor referenced in a test case below, read the characteristic descriptor by executing the test procedure of GATT test case GATT/SR/GAR/BV-06-C in [\[5\]](#).
3. Verify if mandatory characteristic descriptors are available.
4. Verify the value of the characteristic descriptor meets the requirements of the Automation IO Service.



- Expected Outcome

The following verdicts apply to the test cases listed in [Table 4.4](#).

#### Pass verdict

The characteristic descriptor is discovered, the characteristic descriptor is read, and the value of the characteristic descriptor meets the requirements of the Automation IO Service.

#### Characteristic Descriptor Test Cases

Test Case	Value Requirements
<b>4.6.1</b> <b>AIOs/SR/DES/BV-01-C [Digital - Client Characteristic Configuration Descriptor]</b>	0x0000, 0x0001 (if the Characteristic Properties bitmap value is 0x12, 0x16, 0x1A, 0x1E, 0x92, 0x96, 0x9A or 0x9E) or 0x0002 (if the Characteristic Properties bitmap value is 0x22, 0x26, 0x2A, 0x2E, 0xA2, 0xA6 0xAA or 0xAE) or not present (if the Characteristic Property Bitmap value is 0x02, 0x06, 0x0A, 0x0C, 0x0E, 0x82, 0x86 0x8A, 0x8C or 0x8E). ([3] 3.1.2).
<b>4.6.2</b> <b>AIOs/SR/DES/BV-02-C [Digital - Number of Digitals Descriptor]</b>	Verify that the number corresponds to the number of digital signals supported by the IO Module (IOM) device ([3] 3.1.1).
<b>4.6.3</b> <b>AIOs/SR/DES/BV-03-C [Digital - Characteristic Presentation Format Descriptor]</b>	The format field is always set to 0x1B. The exponent, unit and descriptor fields shall always have the value 0x00 ([3] 3.1.2).  Verify that the Name Space has the value 0x01 and that the Description has the value 0x0001 or higher and is not the same as for another Digital ([3] 3.1.2).
<b>4.6.4</b> <b>AIOs/SR/DES/BV-04-C [Digital - Characteristic Extended Properties Descriptor]</b>	Verify that the value is 0x0000 or 0x0002 ([3] 3.1.2).
<b>4.6.5</b> <b>AIOs/SR/DES/BV-05-C [Digital - Characteristic User Description Descriptor]</b>	Verify that value field is a null string or valid string.  If the Characteristic Extended Properties exists and has the value of 0x0002, write a string to the value field and verify it by reading it ([3] 3.1.2).
<b>4.6.6</b> <b>AIOs/SR/DES/BV-06-C [Digital - Value Trigger Setting Descriptor]</b>	Verify that the condition part of the value has value of 0x00, 0x04 or 0x07 ([3] 3.5.1).
<b>4.6.7</b> <b>AIOs/SR/DES/BV-07-C [Digital - Time Trigger Setting Descriptor]</b>	Verify that a Time Trigger Setting Descriptor exists for this characteristics ([3] 3.5.2).  Verify that condition part of the value has value of 0x00, 0x01, 0x02 or 0x03 ([3] 3.5.2).

Test Case	Value Requirements
<b>4.6.8</b> <b>AIOS/SR/DES/BV-08-C</b> <b>[Analog - Client</b> <b>Characteristic Configuration</b> <b>Descriptor]</b>	0x0000, 0x0001 (if the Characteristic Properties bitmap value is 0x12, 0x16, 0x1A, 0x1E, 0x92, 0x96, 0x9A or 0x9E) or 0x0002 (if the Characteristic Properties bitmap value is 0x22, 0x26, 0x2A, 0x2E, 0xA2, 0xA6 0xAA or 0xAE) or not present (if the Characteristic Property Bitmap value is 0x02, 0x06, 0x0A, 0x0C, 0x0E, 0x82, 0x86 0x8A, 0x8C or 0x8E). ([3] 3.2.1).
<b>4.6.9</b> <b>AIOS/SR/DES/BV-09-C</b> <b>[Analog - Characteristic</b> <b>Presentation Format</b> <b>Descriptor]</b>	Verify that the format field is 0x04, 0x05, 0x06, 0x0C, 0x0D, 0x0E, 0x16 or 0x18. Verify that the Name Space has the value 0x01 and that the Description has the value 0x0001 or higher and is not the same as for another Analog. ([3] 3.2.2).
<b>4.6.10</b> <b>AIOS/SR/DES/BV-10-C</b> <b>[Analog - Characteristic</b> <b>Extended Properties</b> <b>Descriptor]</b>	Verify that the value is 0x0000 or 0x0002 ([3] 3.2.2).
<b>4.6.11</b> <b>AIOS/SR/DES/BV-11-C</b> <b>[Analog - Characteristic</b> <b>User Description Descriptor]</b>	Verify that value field is a null string or valid string.  If the Characteristic Extended Properties exists and has the value of 0x0002, write a string to the value field and verify it by reading it ([3] 3.3.2).
<b>4.6.12</b> <b>AIOS/SR/DES/BV-12-C</b> <b>[Analog - Characteristic</b> <b>Valid Range Descriptor]</b>	Verify that the value field consists of 2 consecutive 16 bit values representing lower and upper bounds (inclusive) of the Analog Characteristic ([3] 3.2.2). Verify that the first value is less than or equal to the second. ([3] 3.2.2).
<b>4.6.13</b> <b>AIOS/SR/DES/BV-13-C</b> <b>[Analog– Value Trigger</b> <b>Setting Descriptor]</b>	Verify that the condition part of the value has value of 0x00, 0x01, 0x02, 0x03, 0x05, 0x06 or 0x07 ([3] 3.5.1).
<b>4.6.14</b> <b>AIOS/SR/DES/BV-14-C</b> <b>[Analog – Time Setting</b> <b>Descriptor]</b>	Verify that a Time Trigger Setting Descriptor exists for this characteristics ([3] 3.5.2).  Verify that the condition part of the value has value of 0x00, 0x01, 0x02 or 0x03 ([3] 3.5.2).
<b>4.6.15</b> <b>AIOS/SR/DES/BV-15-C</b> <b>[Aggregate - Client</b> <b>Characteristic Configuration</b> <b>Descriptor]</b>	0x0000, 0x0001 (if the Characteristic Properties bitmap value is 0x12) or 0x0002 (if the Characteristic Properties bitmap value is 0x22) or not present (if the Characteristic Property Bitmap value is 0x02) ([3] 3.3.2).

Table 4.4: Characteristic Descriptor Test Cases

## 4.7 Characteristic Read

- Test Purpose

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

The verification is performed one characteristic at a time, as enumerated in the test cases in [Table 4.5](#) using this generic test procedure:

- Reference

[\[3\]](#) 3.1.1, 3.2.1 and 3.3.1

- Initial Condition

The handle of each characteristic value referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in [Section 4.4](#) or is known to the Lower Tester by other means.

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

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

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.5](#):

1. Read the characteristic value by executing the test procedure of GATT test case GATT/SR/GAR/BV-01-C in [\[5\]](#).
2. Verify that the characteristic value meets the requirements of the Automation IO Service.

- Expected Outcome

The following verdicts apply to the test cases listed in [Table 4.5](#).

Pass verdict

The characteristic is successfully read and the characteristic value meets the requirements of the Automation IO Service.

#### Characteristic Read Value Test Cases

Test Case	Value (Requirements)
<b>4.7.1</b> <b><a href="#">AIOS/SR/CR/BV-01-C [Characteristic Read – Digital]</a></b>	For the first readable Digital, verify that the value read corresponds to the value set by the Upper Tester. ( <a href="#">[3]</a> 3.1.1).
<b>4.7.2</b> <b><a href="#">AIOS/SR/CR/BV-02-C [Characteristic Read – Analog]</a></b>	For the first readable Analog, verify that the value read corresponds to the value set by the Upper Tester. ( <a href="#">[3]</a> 3.2.1).

Test Case	Value (Requirements)
<b>4.7.3</b> <b>AIOS/SR/CR/BV-03-C [Characteristic Read – Aggregate]</b>	Verify that the value read corresponds to the values (aggregated digital inputs and analog inputs) set by the Upper Tester. ([3] 3.3.1).

Table 4.5: Characteristic Read Value Test Cases

## 4.8 Characteristic Write

- Test Purpose

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

The verification is performed one characteristic at a time, as enumerated in the test cases in [Table 4.6: Characteristic Write Value Test Cases](#), using this generic test procedure:

- Reference

[\[3\]](#) 3.1.1, 3.2.1

- Initial Condition

The handle of each characteristic value referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in [Section 4.4](#) or is known to the Lower Tester by other means.

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

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

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.6](#):

- Write the characteristic value by executing the test procedure of GATT test case GATT/SR/GAW/BV-03-C in [\[5\]](#).
- Verify that the written characteristic value meets the requirements of the Automation IO Service and corresponds to the values seen in the Upper Tester.

- Expected Outcome

The following pass and fail verdicts apply to the test cases listed in [Table 4.6](#):

Pass verdict

The characteristic value is successfully written.

**Characteristic Write Value Test Cases**

Test Case	Value (Requirements)
4.8.1 <a href="#">AIOS/SR/CW/BV-01-C [Characteristic Write – Digital]</a>	For the first writable Digital Characteristic, verify that the value is successfully written. ([3] 3.1.1)
4.8.2 <a href="#">AIOS/SR/CW/BV-02-C [Characteristic Write – Analog]</a>	For the first writable Analog Characteristic, verify that the value is successfully written ([3] 3.2.1)

Table 4.6: Characteristic Write Value Test Cases

## 4.9 Characteristic Write without Response

- Test Purpose

This test group contains test cases to write without response and verify that the characteristic values required by the service are compliant.

The verification is performed one characteristic at a time, as enumerated in the test cases in [Table 4.7](#), using this generic test procedure:

- Reference

[\[3\] 3.1.1, 3.2.1](#)

- Initial Condition

The handle of each characteristic value referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in [Section 4.4](#) or is known to the Lower Tester by other means.

The optional property “Write without response” is set.

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

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

- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.7](#):

1. Write the characteristic value by executing the test procedure of GATT test case GATT/SR/GAW/BV-01-C in [\[5\]](#).
2. Verify that the written characteristic value meets the requirements of the Automation IO Service and corresponds to the values seen in the Upper Tester.

- Expected Outcome

The following pass and fail verdicts apply to the test cases listed in [Table 4.7](#):

#### Pass verdict

The characteristic value is successfully written.

#### Characteristic Write Value without Response Test Cases

Test Case	Value (Requirements)
<b>4.9.1</b> <b>AIOS/SR/CW/BV-03-C [Characteristic Write without Response – Digital]</b>	For the first Digital Characteristic supporting Write without Response, verify that the value is successfully written. ([3] 3.1.1).
<b>4.9.2</b> <b>AIOS/SR/CW/BV-04-C [Characteristic Write without Response – Analog]</b>	For the first Analog Characteristic supporting Write without Response, verify that the value is successfully written ([3] 3.2.1).

Table 4.7: Characteristic Write Value without Response Test Cases

## 4.10 Configure Indication and Notification

- Test Purpose

This test group contains test cases to verify compliant operation in response to enable and disable characteristic indication or notification.

The verification is performed one characteristic at a time, as enumerated in the test cases in [Table 4.8](#), using this generic test procedure:

- Reference

[\[3\] 3.1.2, 3.2.2, 3.3.2](#)

- Initial Condition

The handle of each characteristic value referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in [Section 4.3.2](#) or is known to the Lower Tester by other means.

The handle of the client characteristic configuration descriptor of each characteristic referenced in the test cases below has been previously discovered by the Lower Tester during the test procedure in [Section 4.6](#) or is known to the Lower Tester by other means.

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

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



- Test Procedure

The following test procedure applies to the test cases listed in [Table 4.8](#):

1. Disable indication or notification by writing value 0x0000 to the client characteristic configuration descriptor of the first available digital or analog characteristic using the test procedure of GATT test case GATT/SR/GAW/BV-08-C in [\[5\]](#).
2. If the test case is for notification, enable notification by writing value 0x0001 to the client characteristic configuration descriptor of the characteristic.
3. If the test case is for indication, enable indication by writing value 0x0002 to the client characteristic configuration descriptor of the characteristic.
4. The Lower Tester reads the value of the client characteristic configuration descriptor.

- Expected Outcome

The following pass and fail verdicts apply to the test cases listed in [Table 4.8](#):

Pass verdict

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

#### Configure Indication and Notification Test Cases

Test Case	Value (Requirements)
<b>4.10.1</b> <b>AIOS/SR/CON/BV-01-C [Configure Notification – Digital]</b>	0x0001 ( <a href="#">[3]</a> 3.1.2).
<b>4.10.2</b> <b>AIOS/SR/CON/BV-02-C [Configure Indication – Digital]</b>	0x0002 ( <a href="#">[3]</a> 3.1.2).
<b>4.10.3</b> <b>AIOS/SR/CON/BV-03-C [Configure Notification – Analog]</b>	0x0001 ( <a href="#">[3]</a> 3.2.2).
<b>4.10.4</b> <b>AIOS/SR/CON/BV-04-C [Configure Indication – Analog]</b>	0x0002 ( <a href="#">[3]</a> 3.2.2).
<b>4.10.5</b> <b>AIOS/SR/CON/BV-05-C [Configure Notification – Aggregate]</b>	0x0001 ( <a href="#">[3]</a> 3.3.2).
<b>4.10.6</b> <b>AIOS/SR/CON/BV-06-C [Configure Indication – Aggregate]</b>	0x0002 ( <a href="#">[3]</a> 3.3.2).

Table 4.8: Configure Indication and Notification Test Cases

## 4.11 Digital/ Aggregate Notification Test Cases

- Test Purpose

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

The verification is done if a Digital characteristic with Read Property is available, when enumerated in the test cases in [Table 4.9](#).

Verify that the IUT can send notifications of a Digital or Aggregate characteristic. If an Aggregate characteristic is available this will be used for notification.

If multiple digital characteristics are present the verification is performed using first available characteristics present, as enumerated in the test cases in [Table 4.9](#), using this generic test procedure:

- Reference

[\[3\]](#) 3.1

- Initial Condition

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

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

- Test Procedure

1. If a Custom Condition is not used update the Value Trigger Setting and Time Trigger Setting according to the test cases in [Table 4.9](#).
2. Configure the Digital or Aggregate characteristic for notification (both cannot be configured for notification at the same time), see [Section 4.10](#).
3. Perform an action on the IUT that will induce it, once connected, to send notifications of the Digital or Aggregate characteristic (see [Table 4.9](#) for the requirements on how this is done).
4. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
5. If required, the Upper Tester is used to trigger the notification.
6. The Lower Tester receives an *ATT\_Handle\_Value\_Notification* from the IUT containing the Digital or Aggregate characteristic handle and value.
7. Verify that the characteristic value meets the requirements of the Automation IO Service and the value set/given by the Upper Tester.
8. If required perform an action to stop notifications and then repeat steps 5-7 until the Lower Tester receives additionally at least one more notification.
9. The Lower Tester configures the Digital or Aggregate characteristic to disable notifications.
10. Repeat steps 1-2 with notifications disabled.
11. Verify that the Lower Tester does not receive an *ATT\_Handle\_Value\_Notification* from the IUT containing the Digital characteristic or the Aggregate characteristic (depending on which is used).



- Expected Outcome:

Pass verdict

If a Value Trigger Setting descriptor and Time Trigger Setting descriptor is used to trigger the notification, two responses are valid for the writing of the ValueTrigger Setting or Time Trigger Setting Condition value:

- The IUT returns the error code “Trigger condition value not supported” (see [3] 1.6). In this case, test execution shall cease with a PASS verdict applied.
- The IUT accepts the value written and the test continues.
- The IUT sends one or more notifications of the Digital or Aggregate characteristic.
- The value of each field of the characteristic meets the requirements of the Automation IO Service and has the same value as given/set by the Upper Tester.
- The IUT stops sending notifications of the Digital or Aggregate characteristic after the Lower Tester configures the characteristic to disable notifications.

#### Digital Notification Test Cases

Test Case	Requirements on the Test Case
<b>4.11.1</b> <b>AIOS/SR/CN/BV-01-C [Digital Notification – Custom Condition]</b>	Used when a custom condition is available. Do the necessary offline actions to enable Notification ([3] 3.1.1).
<b>4.11.2</b> <b>AIOS/SR/CN/BV-02-C [Digital Notification – Value Trigger Setting Condition value 0x00 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1). No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2). Verify that notifications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.11.3</b> <b>AIOS/SR/CN/BV-03-C [Digital Notification – Value Trigger Setting Condition value 0x04 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1). No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2). Verify that notifications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.11.4</b> <b>AIOS/SR/CN/BV-04-C [Digital Notification – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x01]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1). Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2). Verify that notifications are not sent when the value conditions are fulfilled. Verify that notifications are sent when the time condition is fulfilled ([3] 3.5.1 and 3.5.2).

Test Case	Requirements on the Test Case
<b>4.11.5</b> <b>AIOS/SR/CN/BV-05-C [Digital Notification – Value Trigger Setting Condition value 0x04 and the Time Trigger Setting condition is 0x01]</b>	<p>Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are not sent when the value conditions are fulfilled. Verify that notifications are sent when the time condition is fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.11.6</b> <b>AIOS/SR/CN/BV-06-C [Digital Notification – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.11.7</b> <b>AIOS/SR/CN/BV-07-C [Digital Notification – Value Trigger Setting Condition value 0x04 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.11.8</b> <b>AIOS/SR/CN/BV-08-C [Digital Notification – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.11.9</b> <b>AIOS/SR/CN/BV-09-C [Digital Notification – Value Trigger Setting Condition value 0x04 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>

Table 4.9: Digital Notification Test Cases

## 4.12 Analog /Aggregate Notification Test Cases

- Test Purpose

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



The verification is done one Analog characteristic with Read Property at a time, as enumerated in the test cases in [Table 4.10](#).

Verify that the IUT can send notifications of an Analog or Aggregate characteristic. If an Aggregate characteristic is available this will be used for notification.

The verification is performed one characteristic at a time (first available if multiple analog characteristics are present), as enumerated in the test cases in [Table 4.10](#), using this generic test procedure:

- Reference

[\[3\]](#) 3.2

- Initial Condition

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

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

- Test Procedure

1. If a Custom Condition is not used update the Value Trigger Setting and Time Trigger Setting according to the test cases in [Table 4.10](#). The Value Trigger Setting should be set according to [IXIT \[7\]](#).
2. Configure the Analog or Aggregate characteristic for notification (both cannot be configured for notification at the same time), see [Section 4.10](#).
3. Perform an action on the IUT that will induce it, once connected, to send notifications of the Analog or Aggregate characteristic (see [Table 4.10](#) for the requirements on how this is done).
4. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
5. If required, the Upper Tester is used to trigger the notification.
6. The Lower Tester receives an *ATT\_Handle\_Value\_Notification* from the IUT containing the Analog characteristic handle and value.
7. Verify that the characteristic value meets the requirements of the Automation IO Service and the value set/given by the Upper Tester.
8. If required perform an action to stop notifications and then repeat steps 5-7 until the Lower Tester receives additionally at least one more notification.
9. The Lower Tester configures the Analog or Aggregate characteristic to disable notifications.
10. Repeat steps 1-2 with notifications disabled.
11. Verify that the Lower Tester does not receive an *ATT\_Handle\_Value\_Notification* from the IUT containing the Analog or Aggregate characteristic.

- Expected Outcome

#### Pass verdict

If a Trigger Setting descriptor is used to enable the notification, two responses are valid for the writing of the Trigger Setting Condition value:

- The IUT returns the error code "Trigger condition value not supported" (see [3] 1.6). In this case, test execution shall cease with a PASS verdict applied.
- The IUT accepts the value written and the test continues.
- The IUT sends one or more notifications of the Analog or Aggregate characteristic.
- The value of each field of the characteristic meets the requirements of the Automation IO Service and has the same value as given/set by the Upper Tester.
- The IUT stops sending notifications of the Analog or Aggregate characteristic after the Lower Tester configures the characteristic to disable notifications.

#### Analog Notification Test Cases

Test Case	Requirements on the Test Case
<b>4.12.1</b> <b>AIOS/SR/CN/BV-10-C [Analog Notification – Custom Condition]</b>	Used when a custom condition is available. Do the necessary offline actions to enable Notification ([3] 3.2.1).
<b>4.12.2</b> <b>AIOS/SR/CN/BV-11-C [Analog Notification – Value Trigger Setting Condition value 0x00 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).  No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2).  Verify that notifications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.12.3</b> <b>AIOS/SR/CN/BV-12-C [Analog Notification – Value Trigger Setting Condition value 0x01 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1).  No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2).  Verify that notifications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.12.4</b> <b>AIOS/SR/CN/BV-13-C [Analog Notification – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x01]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).  Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2).  Verify that notifications are not sent when the value condition is fulfilled. Verify that notifications are sent when the time condition is fulfilled ([3] 3.5.1 and 3.5.2).

Test Case	Requirements on the Test Case
<b>4.12.5</b> <b>AIOS/SR/CN/BV-14-C [Analog Notification – Value Trigger Setting Condition value 0x01 and the Time Trigger Setting condition is 0x01]</b>	<p>Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are not sent when the value conditions are fulfilled. Verify that notifications are sent when the time condition is fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.12.6</b> <b>AIOS/SR/CN/BV-15-C [Analog Notification – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.12.7</b> <b>AIOS/SR/CN/BV-16-C [Analog Notification – Value Trigger Setting Condition value 0x01 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.12.8</b> <b>AIOS/SR/CN/BV-17-C [Analog Notification – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.12.9</b> <b>AIOS/SR/CN/BV-18-C [Analog Notification – Value Trigger Setting Condition value 0x01 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that notifications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>

Table 4.10: Analog Notification Test Cases

## 4.13 Digital/ Aggregate Indication Test Cases

- Test Purpose

This test group contains test cases to verify compliant operation in response to enable and disable characteristic indication.

The verification is done if a Digital characteristic with Read Property is available, when enumerated in the test cases in Section 4.4.

Verify that the IUT can send indications of a Digital or Aggregate characteristic. If an Aggregate characteristic is available this will be used for notification.

The verification is performed one characteristic at a time (first available if multiple digital characteristics are present), as enumerated in the test cases in Table 4.11, using this generic test procedure:

- Reference

[3] 3.1

- Initial Condition

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in Section 4.2.1 if using an LE transport or Section 4.2.2 if using a BR/EDR transport.

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

- Test Procedure

1. If a Custom Condition is not used update the Value Trigger Setting and Time Trigger Setting according to the test cases in Table 4.11.
2. Configure the Digital or Aggregate characteristic for indication (both cannot be configured for indication at the same time), see Section 4.10.
3. Perform an action on the IUT that will induce it, once connected, to send indications of the Digital or Aggregate characteristic (see Table 4.11 for the requirements on how this is done).
4. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
5. If required the Upper Tester is used to trigger the indication.
6. The Lower Tester receives an *ATT\_Handle\_Value\_Indication* from the IUT containing the Digital characteristic handle and value.
7. Verify that the characteristic value meets the requirements of the Automation IO Service and the value set/given by the Upper Tester.
8. If required perform an action to stop indications and then repeat steps 5-7 until the Lower Tester receives additionally at least one more indication.
9. The Lower Tester configures the Digital or Aggregate characteristic to disable indications.
10. Repeat steps 1-2 with indications disabled.
11. Verify that the Lower Tester does not receive an *ATT\_Handle\_Value\_Indication* from the IUT containing the Digital characteristic or the Aggregate characteristic (depending on which is used).

- Expected Outcome:

Pass verdict

If a Value Trigger Setting descriptor and Time Trigger Setting descriptor is used to trigger the indication, two responses are valid for the writing of the Value Trigger Setting or Time Trigger Setting Condition value:

- The IUT returns the error code “Trigger condition value not supported” (see [3] 1.6). In this case, test execution shall cease with a PASS verdict applied.
- The IUT accepts the value written and the test continues.
- The IUT sends one or more indications of the Digital or Aggregate characteristic.
- The value of each field of the characteristic meets the requirements of the Automation IO Service and has the same value as given/set by the Upper Tester.
- The IUT stops sending indications of the Digital or Aggregate characteristic after the Lower Tester configures the characteristic to disable indications.

#### Digital Indication Test Cases

Test Case	Requirements on the Test Case
<b>4.13.1</b> <b>AIOS/SR/CI/BV-01-C [Digital Indication – Custom Condition]</b>	Used when a custom condition is available. Do the necessary offline actions to enable Indication ([3] 3.1.1).
<b>4.13.2</b> <b>AIOS/SR/CI/BV-02-C [Digital Indication – Value Trigger Setting Condition value 0x00 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1). No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2). Verify that indications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.13.3</b> <b>AIOS/SR/CI/BV-03-C [Digital Indication – Value Trigger Setting Condition value 0x04 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1). No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2). Verify that indications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.13.4</b> <b>AIOS/SR/CI/BV-04-C [Digital Indication – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x01]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1). Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2). Verify that indications are not sent when the value conditions are fulfilled. Verify that indications are sent when the time condition is fulfilled ([3] 3.5.1 and 3.5.2).



Test Case	Requirements on the Test Case
<b>4.13.5</b> <b>AIOS/SR/CI/BV-05-C [Digital Indication – Value Trigger Setting Condition value 0x04 and the Time Trigger Setting condition is 0x01]</b>	<p>Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are not sent when the value conditions are fulfilled. Verify that indications are sent when the time condition is fulfilled. ([3] 3.5.1 and 3.5.2).</p>
<b>4.13.6</b> <b>AIOS/SR/CI/BV-06-C [Digital Indication – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.13.7</b> <b>AIOS/SR/CI/BV-07-C [Digital Indication – Value Trigger Setting Condition value 0x04 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.13.8</b> <b>AIOS/SR/CI/BV-08-C [Digital Indication – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.13.9</b> <b>AIOS/SR/CI/BV-09-C [Digital Indication – Value Trigger Setting Condition value 0x04 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x04 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>

Table 4.11: Digital Indication Test Cases

## 4.14 Analog/ Aggregate Indication Test Cases

- Test Purpose

This test group contains test cases to verify compliant operation in response to enable and disable characteristic indication.





The verification is done one Analog characteristic with Read Property at a time, as enumerated in the test cases in [Table 4.12](#).

Verify that the IUT can send indications of an Analog or Aggregate characteristic. If an Aggregate characteristic is available this will be used for indication.

The verification is performed one characteristic at a time (first available if multiple analog characteristics are present), as enumerated in the test cases in [Table 4.12](#), using this generic test procedure:

- Reference

[\[3\]](#) 3.1

- Initial Condition

If the IUT requires a bonding procedure then perform a bonding procedure.

Establish an ATT Bearer connection between the Lower Tester and IUT as defined in [Section 4.2.1](#) if using an LE transport or [Section 4.2.2](#) if using a BR/EDR transport.

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

- Test Procedure

1. If a Custom Condition is not used to update the Value Trigger Setting and Time Trigger Setting according to the test cases in [Table 4.12](#), the Value Trigger Setting should be set according to the [IXIT \[7\]](#).
2. Configure the Analog or Aggregate characteristic for indication (both cannot be configured for indication at the same time), see [Section 4.10](#).
3. Perform an action on the IUT that will induce it, once connected, to send indications of the Analog or Aggregate characteristic (see [Table 4.12](#) for the requirements on how this is done).
4. A connection is established between the Lower Tester and IUT meeting the security requirements of the IUT, if not already done so prior to step 1.
5. If required the Upper Tester is used to trigger the indication.
6. The Lower Tester receives an *ATT\_Handle\_Value\_Indication* from the IUT containing the Analog characteristic handle and value.
7. Verify that the characteristic value meets the requirements of the Automation IO Service and the value set/given by the Upper Tester.
8. If required perform an action to stop indications and then repeat steps 5-7 until the Lower Tester receives additionally at least one more indication.
9. The Lower Tester configures the Analog or Aggregate characteristic to disable indications.
10. Repeat steps 1-2 with indications disabled.
11. Verify that the Lower Tester does not receive an *ATT\_Handle\_Value\_Indication* from the IUT containing the Analog or Aggregate characteristic.

- Expected Outcome

#### Pass verdict

If a Trigger Setting descriptor is used to enable the indication, two responses are valid for the writing of the Trigger Setting Condition value:

- The IUT returns the error code "Trigger condition value not supported" (see [3] 1.6). In this case, test execution shall cease with a PASS verdict applied.
- The IUT accepts the value written and the test continues.

The IUT sends one or more indications of the Analog or Aggregate characteristic.

The value of each field of the characteristic meets the requirements of the Automation IO Service has the same value as given/set by the Upper Tester.

The IUT stops sending indications of the Analog or Aggregate characteristic after the Lower Tester configures the characteristic to disable indications.

### Analog Indication Test Cases

Test Case	Requirements on the Test Case
<b>4.14.1</b> <b>AIOS/SR/CI/BV-10-C [Analog Indication – Custom Condition]</b>	Used when a custom condition is available. Do the necessary offline actions to enable Indication ([3] 3.2.1).
<b>4.14.2</b> <b>AIOS/SR/CI/BV-11-C [Analog Indication – Value Trigger Setting Condition value 0x00 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1). No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2). Verify that indications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.14.3</b> <b>AIOS/SR/CI/BV-12-C [Analog Indication – Value Trigger Setting Condition value 0x01 and no Time Trigger Setting condition is available or the Time Trigger Setting condition is 0x00]</b>	Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1). No Time Trigger Setting Descriptor exists or write 0x00 to the Time Trigger Condition Field ([3] 3.5.2). Verify that indications are sent when the value condition is fulfilled ([3] 3.5.1).
<b>4.14.4</b> <b>AIOS/SR/CI/BV-13-C [Analog Indication – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x01]</b>	Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1). Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2). Verify that indications are not sent when the value conditions are fulfilled. Verify that notifications are sent when the time condition is fulfilled ([3] 3.5.1 and 3.5.2).

Test Case	Requirements on the Test Case
<b>4.14.5</b> <b>AIOS/SR/CI/BV-14-C [Analog Indication – Value Trigger Setting Condition value 0x01 and the Time Trigger Setting condition is 0x01]</b>	<p>Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x01 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are not sent when the value conditions are fulfilled. Verify that indications are sent when the time condition is fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.14.6</b> <b>AIOS/SR/CI/BV-15-C [Analog Indication – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition and the time condition are fulfilled ([3] 3.5.1 and 3.5.2).</p>
<b>4.14.7</b> <b>AIOS/SR/CI/BV-16-C [Analog Indication – Value Trigger Setting Condition value 0x01 and the Time Trigger Setting condition is 0x02]</b>	<p>Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x02 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition is fulfilled ([3] 3.5.1).</p>
<b>4.14.8</b> <b>AIOS/SR/CI/BV-17-C [Analog Indication – Value Trigger Setting Condition value 0x00 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x00 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition is fulfilled ([3] 3.5.1).</p>
<b>4.14.9</b> <b>AIOS/SR/CI/BV-18-C [Analog Indication – Value Trigger Setting Condition value 0x01 and the Time Trigger Setting condition is 0x03]</b>	<p>Write 0x01 to the Value Trigger Setting Condition Field ([3] 3.5.1).</p> <p>Write 0x03 to the Time Trigger Condition Field ([3] 3.5.2).</p> <p>Verify that indications are sent when the value condition is fulfilled ([3] 3.5.1).</p>

Table 4.12: Analog Indication Test Cases

## 5 Test Case Mapping

The Test Case Mapping Table (TCMT) maps test cases to specific capabilities in the ICS. Profiles, protocols and services may define multiple roles, and it is possible that a product may implement more than one role. The product shall be tested in all roles for which support is declared in the ICS document.

The columns for the TCMT are defined as follows:

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

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

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

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

Item	Feature	Test case(s)
AIOs 1/2 AND AIOs 2/1	Discover Automation IO Service over LE	AIOs/SR/SD/BV-01-C
AIOs 1/1 AND AIOs 2/1	Discover Automation IO Service over BR/EDR	AIOs/SR/SD/BV-02-C
AIOs 2/2 OR AIOs 2/3 OR AIOs 2/16 OR AIOs 2/17 OR AIOs 2/30	Verify mandatory Characteristic support combinations	AIOs/SR/COM/BV-01-C AIOs/SR/COM/BV-03-C
AIOs 2/2 OR AIOs 2/3	Digital Characteristic: Definition	AIOs/SR/DEC/BV-01-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/4	Digital Characteristic: Read	AIOs/SR/CR/BV-01-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/5	Digital Characteristic: Write	AIOs/SR/CW/BV-01-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/15	Digital Characteristic: Write Without Response	AIOs/SR/CW/BV-03-C
AIOs 2/16 OR AIOs 2/17	Analog Characteristic: Definition	AIOs/SR/DEC/BV-02-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/18	Analog Characteristic: Read	AIOs/SR/CR/BV-02-C

Item	Feature	Test case(s)
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/19	Analog Characteristic: Write	AIOs/SR/CW/BV-02-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/29	Analog Characteristic: Write Without Response	AIOs/SR/CW/BV-04-C
AIOs 2/30	Aggregate Characteristic: Read	AIOs/SR/DEC/BV-03-C AIOs/SR/COM/BV-02-C AIOs/SR/CR/BV-03-C
AIOs 2/30 AND AIOs 2/31	Aggregate Characteristic: Notifications	AIOs/SR/CON/BV-05-C
AIOs 2/30 AND AIOs 2/32	Aggregate Characteristic: Indications	AIOs/SR/CON/BV-06-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/6	Digital Characteristic: Notifications	AIOs/SR/CON/BV-01-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/7	Digital Characteristic: Indications	AIOs/SR/CON/BV-02-C
(AIOs 2/2 OR AIOs 2/3) AND (AIOs 2/6 OR AIOs 2/7)	Digital Characteristic: Client Characteristic Configuration descriptor	AIOs/SR/DES/BV-01-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/8	Digital Characteristic: Number of Digitals descriptor	AIOs/SR/DES/BV-02-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/11	Digital Characteristic: Presentation Format descriptor	AIOs/SR/DES/BV-03-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/12	Digital Characteristic: Characteristic Extended Properties descriptor	AIOs/SR/DES/BV-04-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/13	Digital Characteristic: User Description descriptor	AIOs/SR/DES/BV-05-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/9	Digital Characteristic: Value Trigger Settings descriptor	AIOs/SR/DES/BV-06-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/10	Digital Characteristic: Time Trigger Settings descriptor	AIOs/SR/DES/BV-07-C

Item	Feature	Test case(s)
(AIOs 2/16 OR AIOs 2/17) AND (AIOs 2/20 OR AIOs 2/21)	Analog Characteristic: Client Characteristic Configuration descriptor	AIOs/SR/DES/BV-08-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/20	Analog Characteristic: Notifications	AIOs/SR/CON/BV-03-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/21	Analog Characteristic: Indications	AIOs/SR/CON/BV-04-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/24	Analog Characteristic: Presentation Format descriptor	AIOs/SR/DES/BV-09-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/25	Analog Characteristic: Characteristic Extended Properties descriptor	AIOs/SR/DES/BV-10-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/26	Analog Characteristic: User Description descriptor	AIOs/SR/DES/BV-11-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/28	Analog Characteristic: Valid Range descriptor	AIOs/SR/DES/BV-12-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/22	Analog Characteristic: Value Trigger Settings descriptor	AIOs/SR/DES/BV-13-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/23	Analog Characteristic: Time Trigger Settings descriptor	AIOs/SR/DES/BV-14-C
AIOs 2/30 AND (AIOs 2/31 OR AIOs 2/32)	Aggregate Characteristic: Client Characteristic Configuration descriptor	AIOs/SR/DES/BV-15-C
(AIOs 2/2 OR AIOs 2/3) AND (AIOs 2/6 OR (AIOs 2/30 AND AIOs 2/31 AND AIOs 2/33))	Digital Characteristic: Notifications with Custom Condition	AIOs/SR/CN/BV-01-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/9 AND (AIOs 2/6 OR (AIOs 2/30 AND AIOs 2/31 AND AIOs 2/33))	Digital Characteristic: Notifications with Value Trigger Settings only.	AIOs/SR/CN/BV-02-C AIOs/SR/CN/BV-03-C

Item	Feature	Test case(s)
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/9 AND AIOs 2/10 AND (AIOs 2/6 OR (AIOs 2/30 AND AIOs 2/31 AND AIOs 2/33))	Digital Characteristic: Notifications with Value and Time Trigger Settings	AIOs/SR/CN/BV-04-C AIOs/SR/CN/BV-05-C AIOs/SR/CN/BV-06-C AIOs/SR/CN/BV-07-C AIOs/SR/CN/BV-08-C AIOs/SR/CN/BV-09-C
(AIOs 2/2 OR AIOs 2/3) AND (AIOs 2/7 OR (AIOs 2/30 AND AIOs 2/32 AND AIOs 2/33))	Digital Characteristic: Indications with Custom Condition	AIOs/SR/CI/BV-01-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/9 AND (AIOs 2/7 OR (AIOs 2/30 AND AIOs 2/32 AND AIOs 2/33))	Digital Characteristic: Indications with Value Trigger Settings only	AIOs/SR/CI/BV-02-C AIOs/SR/CI/BV-03-C
(AIOs 2/2 OR AIOs 2/3) AND AIOs 2/9 AND AIOs 2/10 AND (AIOs 2/7 OR (AIOs 2/30 AND AIOs 2/32 AND AIOs 2/33))	Digital Characteristic: Indications with Value and Time Trigger Settings	AIOs/SR/CI/BV-04-C AIOs/SR/CI/BV-05-C AIOs/SR/CI/BV-06-C AIOs/SR/CI/BV-07-C AIOs/SR/CI/BV-08-C AIOs/SR/CI/BV-09-C
(AIOs 2/16 OR AIOs 2/17) AND (AIOs 2/20 OR (AIOs 2/30 AND AIOs 2/31 AND AIOs 2/33))	Analog Characteristic: Notifications with Custom Condition	AIOs/SR/CN/BV-10-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/22 AND (AIOs 2/20 OR (AIOs 2/30 AND AIOs 2/31 AND AIOs 2/33))	Analog Characteristic: Notifications with Value Trigger Settings only	AIOs/SR/CN/BV-11-C AIOs/SR/CN/BV-12-C

Item	Feature	Test case(s)
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/22 AND AIOs 2/23 AND (AIOs 2/20 OR (AIOs 2/30 AND AIOs 2/31 AND AIOs 2/33))	Analog Characteristic: Notifications with Value and Time Trigger Settings	AIOs/SR/CN/BV-13-C AIOs/SR/CN/BV-14-C AIOs/SR/CN/BV-15-C AIOs/SR/CN/BV-16-C AIOs/SR/CN/BV-17-C AIOs/SR/CN/BV-18-C
(AIOs 2/16 OR AIOs 2/17) AND (AIOs 2/21 OR (AIOs 2/30 AND AIOs 2/32 AND AIOs 2/33))	Analog Characteristic: Indications with Custom Condition	AIOs/SR/CI/BV-10-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/22 AND (AIOs 2/21 OR (AIOs 2/30 AND AIOs 2/32 AND AIOs 2/33))	Analog Characteristic: Indications with Value Trigger Settings only	AIOs/SR/CI/BV-11-C AIOs/SR/CI/BV-12-C
(AIOs 2/16 OR AIOs 2/17) AND AIOs 2/22 AND AIOs 2/23 AND (AIOs 2/21 OR (AIOs 2/30 AND AIOs 2/32 AND AIOs 2/33))	Analog Characteristic: Indications with Value and Time Trigger Settings	AIOs/SR/CI/BV-13-C AIOs/SR/CI/BV-14-C AIOs/SR/CI/BV-15-C AIOs/SR/CI/BV-16-C AIOs/SR/CI/BV-17-C AIOs/SR/CI/BV-18-C

Table 5.1: Test Case Mapping



## 6 Revision History and Contributors

### Revision History

Revision History	Date	Comments
1.0.0	2015-07-21	Prepared for publication
1.0.1r00	2016-05-16	Converted to new Test Case ID conventions as defined in TSTO v4.1.
1.0.1	2016-07-13	Prepared for TCRL 2016-1 publication.
1.0.1 edition 2r00	2018-11-29	Editorial changes only. Template updated. Revision History and Contributors moved to the end of the document.
1.0.1 edition 2	2019-11-11	Updated copyright page and confidentiality markings to support new Documentation Marking Requirements, performed minor formatting updates, and accepted all tracked changes to prepare for edition 2 publication.

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