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TEST SUITE STRUCTURE (TSS) AND TEST PURPOSES (TP) FOR ADVANCED AUDIO DISTRIBUTION PROFILE

Version 1.0 Adopted

Abstract

This document specifies the interoperability test procedure of Advanced Audio Distribution Profile (A2DP).

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- The use of the word *must* is deprecated and shall not be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.
- The use of the word *will* is deprecated and shall not be used when stating mandatory requirements; *will* is only used in statements of fact.
- The word *should* is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is deprecated but not prohibited (*should* equals *is recommended that*).
- The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted*).
- The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

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1 Scope

This document describes the test procedures for testing the interoperability of Bluetooth products implementing the Advanced Audio Distribution Profile (A2DP) [R2]. The test shall ensure that the tested products can interoperate with each other within the Advanced Audio Distribution profile.

The A2DP inherits Generic Audio/Video Distribution profile (GAVDP)[R3] that defines signaling procedures. To test A2DP procedures, it is necessary to initiate a part of the GAVDP procedures, which shall also be tested in this specification. Conformance test for GAVDP procedures are defined in Reference[R5].

2 Terminology and Definitions

BV: Standard ISO test category verifying that an implementation under test (IUT) reacts in conformity with the specification, after receipt or exchange of a valid Protocol Data Unit (PDU).

BI: Standard ISO test category verifying that an IUT reacts in conformity with the specification, after receipt of a syntactically or semantically invalid PDU.

3 Test Suite Structure

3.1 Introduction

The qualification of products claiming their compliance with the Bluetooth specification involves the execution of test suites.

Two types of qualification tests are used therefore: the *conformance tests* and the *interoperability tests*. The A2DP is qualified with interoperability tests.

The interoperability tests aim at ensuring the interoperability between different Bluetooth products by covering functional testing based on operational scenarios.

3.2 Test Suite Structure

This section defines the tree structure of the interoperability tests specified for A2DP. The test suite structure (TSS) is presented in Figure 3-1. The TSS is composed of nested test groups organised in a top down approach.

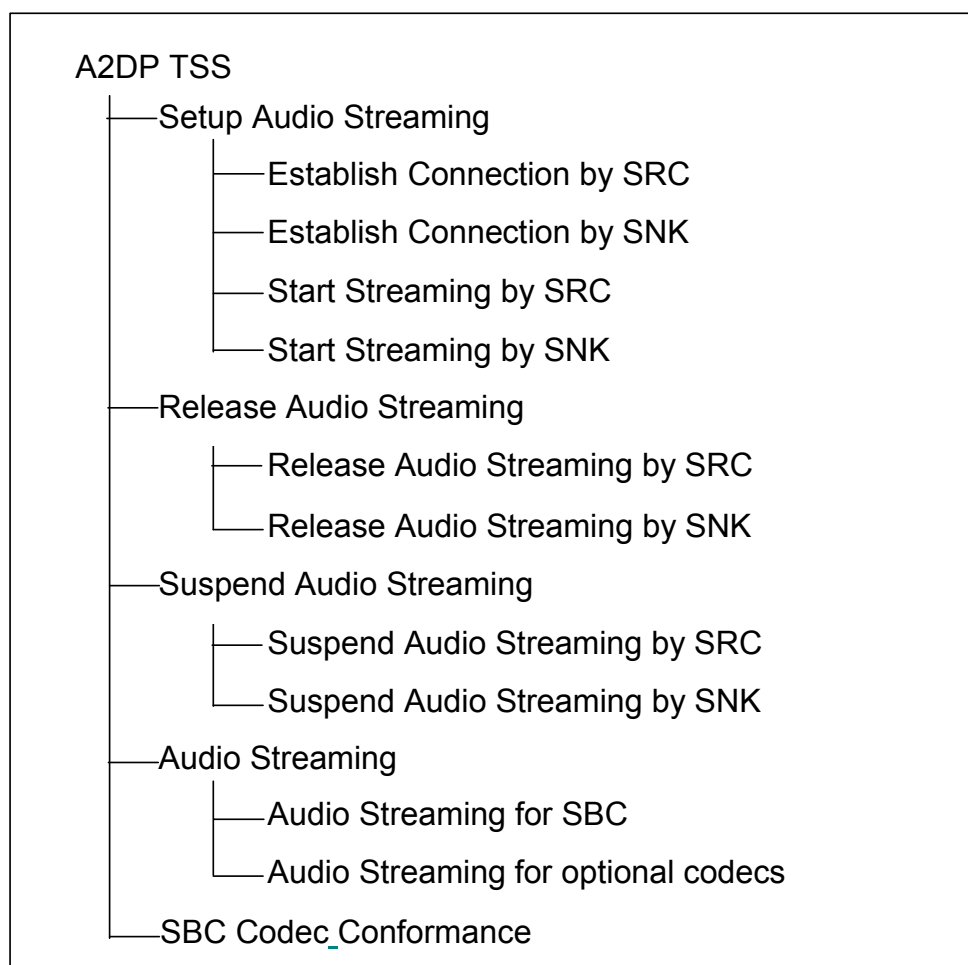


Figure 3-1: A2DP Test Suite Structure

3.3 Test Groups

The test groups are organised in 3 levels.

The first level defines the procedure groups representing the profile services. The second level separates the procedures in functional modules. The last level in each branch contains the standard ISO groups BV and BI.

4 Test Purposes (TP)

This chapter provides the list of test purposes: for each element of the test suite defined in section 3.2, the following is provided:

- more details on the tested functionality,
- the list of test cases.

4.1 Conventions & Assumptions

4.1.1 TP definition conventions

The TPs are defined according to a template following several rules provided in Table 4-1.

TP Id	Unique identifier specified according to the TP naming convention defined in section 4.1.2.
Reference	Contains the references of the subject to be validated by this TP (verified requirements in specification: A2DP [R2]).
Initial Condition	Specifies in which state the IUT shall be to perform this TP.
Test Procedure	Describes the steps to be performed for this TP.
Test Condition	Describes the conditions that shall be maintained during the test procedure.
Expected Outcome	Describes the expected outcome of the TP.
Uncertainties	Provides uncertainties for this TP, if any.
Notes	Provides extra information for this TP.

Table 4-1: TP definition conventions

4.1.2 TP naming conventions

The identifier of the TP is built according to Table 4-2.

Identifier:	TP/<proc>/<xx>-<nn>-<y>...
<proc> = procedure	SET = Setup audio streaming
	REL = Release audio streaming
	SUS = Suspend audio streaming
	AS = Audio streaming
	SC= SBC Codec Conformance
<xx> = type of testing	BV = Valid Behaviour Tests
	BI = Invalid Behaviour Tests
<nn> = sequential	(00-99) = Test purpose number

number	
<y> = scope	C = Conformance test performed on dedicated Bluetooth test system
	E = Early Product Test; performed with standard equipment
	I = Interoperability testing performed as product to product testing

Table 4-2 - TP naming conventions

4.2 Setup Audio Streaming

Test group objectives:

- To verify audio streaming setup

4.2.1 Establish Connection initiated by SRC

Test subgroup objectives:

- To verify that the parameters are configured and stream connection is established by SRC.

4.2.1.1 TP/SET/BV-01-I [Est. Connect. - SRC]

To verify that SRC can establish stream connection successfully.

<i>Reference</i>	5.1.1 in [R2] and 4.1.1 in [R3]
<i>Initial Condition</i>	SRC: Standby mode. SNK: Standby mode.
<i>Test Procedure</i>	Initiate the user action (e.g. press button) on SRC to setup audio streaming
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SRC/SNK: If there is a corresponding indicator, establishment of connection is indicated. SRC/SNK: Start streaming procedure can be initiated afterwards. Fail verdict: SRC/SNK: If there is a corresponding indicator, establishment of connection is not indicated. SRC/SNK: Start streaming is not possible afterwards.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.2.2 Establish Connection initiated by SNK

Test subgroup objectives:

- To verify that the parameters are configured and stream connection is established by SNK.

4.2.2.1 TP/SET/BV-02-I [Est. Connect. - SNK]

To verify that SNK can establish stream connection successfully.

<i>Reference</i>	5.1.1 in [R2] and 4.1.1 in [R3]
<i>Initial Condition</i>	SRC: Standby mode. SNK: Standby mode.
<i>Test Procedure</i>	Initiate the user action (e.g. press button) on SNK to setup audio streaming
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SRC/SNK: If there is a corresponding indicator, establishment of connection is indicated. SRC/SNK: Start streaming procedure can be initiated afterwards. Fail verdict: SRC/SNK: If there is a corresponding indicator, establishment of connection is not indicated. SRC/SNK: Start streaming is not possible afterwards.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.2.3 Start Audio Streaming initiated by SRC

Test subgroup objectives:

- To verify that audio streaming is started by SRC.

4.2.3.1 TP/SET/BV-03-I [Start Stream. - SRC]

To verify that SRC can start audio streaming.

<i>Reference</i>	5.1.1 in [R2] and 4.1.2 in [R3]
<i>Initial Condition</i>	SRC/SNK: Connection has been established.
<i>Test Procedure</i>	Initiate the user action (e.g. press button) on SRC to start audio streaming. No user action may be required when Start streaming is proceeded from Connection establishment consecutively.
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SRC/SNK: - If there is a corresponding indicator, start audio streaming is indicated. - It is possible to start streaming afterwards.

	Fail verdict: SRC/SNK: - If there is a corresponding indicator, audio streaming is not indicated. - It is not possible to start streaming afterwards.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.2.4 Start Audio Streaming initiated by SNK

Test subgroup objectives:

- To verify that audio streaming is started by SNK.

4.2.4.1 TP/SET/BV-04-I [Start Stream. - SNK]

To verify that SNK can start audio streaming.

<i>Reference</i>	5.1.1 in [R2] and 4.1.2 in [R3]
<i>Initial Condition</i>	SRC/SNK: Connection has been established.
<i>Test Procedure</i>	Initiate the user action (e.g. press button) on SNK to start audio streaming. No user action may be required when Start streaming is proceeded from Connection establishment consecutively.
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SRC/SNK: - If there is a corresponding indicator, start audio streaming is indicated. - It is possible to start streaming afterwards. Fail verdict: SRC/SNK: - If there is a corresponding indicator, audio streaming is not indicated. - It is not possible to start streaming afterwards.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.3 Release Audio Streaming

Test group objectives:

- To verify that the audio stream connection is released.

4.3.1 Release Audio Streaming initiated by SRC

Test subgroup objectives:

- To verify that the audio stream connection is released by SRC.

4.3.1.1 TP/REL/BV-01-I [Release Stream. – SRC]

SRC:

To verify that SRC can release streaming

SNK:

To verify that SNK can accept streaming release

<i>Reference</i>	5.1.1 in [R2] and 4.1.3 in [R3]
<i>Initial Condition</i>	SRC/SNK: Streaming connection is established
<i>Test Procedure</i>	SRC: Initiate the user action (e.g. press button) on SRC to release streaming SNK: No user action is required
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SRC/SNK: If there is a corresponding indicator, release audio streaming is indicated. The user action releases audio streaming connection, and is possible to re-establish an audio streaming connection and start audio streaming. Fail verdict: SRC: If there is a corresponding indicator, release audio streaming is not indicated. The user action does not release audio streaming connection, and is not possible to re-establish an audio streaming connection nor start audio streaming.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.3.2 Release Audio Streaming initiated by SNK

Test subgroup objectives:

- To verify that the audio stream connection is released by SNK.

4.3.2.1 TP/REL/BV-02-I [Release Stream. – SNK]

SRC:

To verify that SRC can accept streaming release

SNK:

To verify that SNK can release streaming

<i>Reference</i>	5.1.1 in [R2] and 4.1.3 in [R3]
<i>Initial Condition</i>	SRC/SNK: Streaming connection is established

<i>Test Procedure</i>	<p>SRC: No user action is required</p> <p>SNK: Initiate the user action (e.g. press button) on SNK to release streaming</p>
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	<p>Pass verdict: SRC/SNK: If there is a corresponding indicator, release audio streaming is indicated. The user action releases audio streaming connection and is possible to re-establish an audio streaming connection and start audio streaming.</p> <p>Fail verdict: SNK: If there is a corresponding indicator, release audio streaming is not indicated. The user action does not release audio streaming connection, and is not possible to re-establish an audio streaming connection nor start audio streaming.</p>
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.4 Suspend Audio Streaming

Test group objectives:

- To verify that the audio streaming is suspended.

4.4.1 Suspend Audio Streaming initiated by SRC

Test subgroup objectives:

- To verify that the audio streaming is suspended by SRC.

4.4.1.1 TP/SUS/BV-01-I [Suspend Stream – SRC]

SRC:

To verify that SRC can suspend streaming

SNK:

To verify that SNK can accept streaming suspend

<i>Reference</i>	5.1.1 in [R2] and 4.1.4 in [R3]
<i>Initial Condition</i>	<p>SRC/SNK: Streaming connection is established</p>
<i>Test Procedure</i>	<p>SRC: Initiate the user action (e.g. press button) on SRC to suspend streaming</p> <p>SNK: No user action is required</p>

<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SRC/SNK: If there is a corresponding indicator, suspend audio streaming is indicated. SRC/SNK: It is possible to resume audio streaming Fail verdict: SRC: The user action does not suspend audio streaming connection.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.4.2 Suspend Audio Streaming initiated by SNK

Test subgroup objectives:

- To verify that the audio streaming is suspended by SNK.

4.4.2.1 TP/SUS/BV-02-I [Suspend Stream. – SNK]

SRC:

To verify that SRC can accept streaming suspend

SNK:

To verify that SNK can suspend streaming

<i>Reference</i>	5.1.1 in [R2] and 4.1.4 in [R3]
<i>Initial Condition</i>	SRC/SNK: Streaming connection is established
<i>Test Procedure</i>	SRC: No user action is required SNK: Initiate the user action (e.g. press button) on SNK to suspend streaming
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SRC/SNK: If there is a corresponding indicator, suspend audio streaming is indicated. SRC/SNK: It is possible to resume audio streaming Fail verdict: SNK: The user action does not suspend audio streaming connection.
<i>Uncertainties</i>	NA

Notes | NA

4.5 Audio streaming

Test group objectives:

- To verify the audio streaming

4.5.1 Audio Streaming for SBC

Test subgroup objectives:

- To verify the audio streaming based on SBC format.

4.5.1.1 TP/AS/BV-01-I [Streaming – SBC]

SRC:

To verify that SRC can generate audio data encoded in SBC and send it to the SNK.

SNK:

To verify that SNK can receive the audio data encoded in SBC.

<i>Reference</i>	3.2 in [R2]
<i>Initial Condition</i>	<p>SRC: Test mode for SBC is active if necessary. Streaming connection is established and configured using SBC.</p> <p>SNK: Streaming connection is established and configured using SBC.</p>
<i>Test Procedure</i>	<p>SRC: Start streaming. If defined test vectors are available, it shall be used for the input, otherwise appropriate input is applied.</p> <p>SNK: No user action is required</p>
<i>Test Condition</i>	The test should be performed under normal mode. If the device does not support user selection of SBC, it shall have mandatory codec (SBC) mode for this test case.
<i>Expected Outcome</i>	<p>Pass verdict: SNK: - If the audio output is available, expected output is monitored. Otherwise, the output shall be checked in a different method. - If the test vector is available as an input of SRC, the audio output satisfies the test document of corresponding codec.</p> <p>Fail verdict: SNK: - Expected output is not monitored. - The audio output does not satisfy the test document of corresponding codec.</p>

<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.5.2 Audio Streaming for Optional Codecs

Test subgroup objectives:

- To verify the audio streaming based on optional codec format.

4.5.2.1 TP/AS/BV-02-I [Streaming – Options]

SRC:

To verify that SRC can send audio data encoded in optional codec to SNK.

SNK:

To verify that SNK can receive the audio data encoded in optional codec.

<i>Reference</i>	3.2 in [R2]
<i>Initial Condition</i>	SRC/SNK: Streaming connection is established and configured using optional codec.
<i>Test Procedure</i>	SRC: Start streaming. Defined test vectors for optional codec are used as streaming data. SNK: No user action is required
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: SNK: - If the audio output is available, expected output is monitored. Otherwise, the output shall be checked in a different method. - The audio output satisfies the test document of optional codec. Fail verdict: SNK: - Expected output is not monitored. - The audio output does not satisfy the test document of optional codec.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.6 SBC Codec Conformance Test

Test group objectives:

- To verify that the mandatory codec SBC is properly implemented conform to 9, and compliance to Appendix B in Reference [R2]. See also Appendix A of Reference [R4]

This conformance test is necessary to be tested if the implementation applies to at least one of the following cases:

- ◆ SRC device that generates audio data encoded in SBC.
- ◆ SRC device that transmits audio streams encoded in optional codec to SNK, while the audio stream shall be transcoded into SBC before transmission if SNK is not capable to decode said optional codec.
- ◆ SNK device that decodes audio streams encoded in either SBC or optional codec.

On the other hand, this conformance test is not necessary to be tested if the implementation applies to one of the following cases:

- ◆ SRC device that does not encode audio data, but only transmits audio streams pre-encoded in SBC.
- ◆ SNK device that does not render audio streams encoded in either SBC or optional codec.

4.6.1 SBC Decoder Conformance

Test subgroup objectives:

- To verify that SBC decoder is properly implemented.

4.6.1.1 TP/SC/BV-01-C [SBC Conformance - Decoder]

To verify that SBC decoder is properly implemented on SNK.

To check the required accuracy of the output of a decoder implementation with respect to the output of a reference decoder implementation using conformance bit streams [R6].

<i>Reference</i>	9, Reference [R6] and Section 4.3 and Appendix B in Reference [R2]
<i>Initial Condition</i>	SNK device is in decoding mode of SBC audio stream.
<i>Test Procedure</i>	Input test vectors in Reference [R6].
<i>Test Condition</i>	The test shall be performed under normal condition.
<i>Expected Outcome</i>	Pass verdict: <ul style="list-style-type: none">- The audio output of the implementation satisfies the requirement in 9.4.- If the audio output is available, expected output equivalent to those of reference decoder is monitored. Fail verdict: <ul style="list-style-type: none">- The audio output does not satisfy the requirement in 9.4.- An expected output is not monitored.

<i>Uncertainties</i>	NA
<i>Notes</i>	NA

4.6.2 SBC Encoder Conformance

Test subgroup objectives:

- To verify that SBC encoder is properly implemented.

4.6.2.1 TP/SC/BV-02-C [SBC Conformance - Encoder]

To verify that SBC encoder is properly implemented on SRC.

To check the output of a encoder implementation with respect to the output of a reference encoder implementation.

<i>Reference</i>	9, Reference [R6] and Section 4.3 and Appendix B in Reference [R2]
<i>Initial Condition</i>	SRC device is in encoding mode of SBC audio stream.
<i>Test Procedure</i>	Input test vectors.
<i>Test Condition</i>	The test shall be performed under normal condition with supported parameters defined in Section 4.3 in Reference [R2].
<i>Expected Outcome</i>	Pass verdict: - The encoder output of the implementation satisfies the requirement in 9.4. Fail verdict: - The encoder output does not satisfy the requirement in 9.4.
<i>Uncertainties</i>	NA
<i>Notes</i>	NA

5 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. For dated references, subsequent amendments to or revisions of any of these publications apply to this Bluetooth document only when incorporated in it by amendment or revision,

- [R1]. Bluetooth SIG, Specification of the Bluetooth System, version 1.1
- [R2]. Bluetooth SIG, Specification of the Bluetooth System, Profiles, version 1.0 Advanced Audio Distribution Profile
- [R3]. Bluetooth SIG, Specification of the Bluetooth System, Profiles, version 1.0 Generic Audio/Video Distribution Profile
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- [R9]. Bluetooth SIG, ICS for Generic Audio/Video Distribution Profile
- [R10]. Rec. ITU-R BS.1116-1, "METHODS FOR THE SUBJECTIVE ASSESSMENT OF SMALL IMPAIRMENTS IN AUDIO SYSTEMS INCLUDING MULTICHANNEL SOUND SYSTEMS", 1994-1997
- [R11]. Rec. ITU-R BS.1387-1, "METHOD FOR OBJECTIVE MEASUREMENTS OF PERCEIVED AUDIO QUALITY", 2001

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8 Appendix A – Test cases mapping

This section provides, for each test procedure, the corresponding validated specification(s).

The **Item** reference has the following format: x.y/z, where x.y refers to the table number in the GAVDP ICS document ([R9]), and z is the item number entry in table x.y. If there is no value for z, the whole table x.y is referred. The **Feature** is a description of the capability/feature to be tested, as provided in the ICS document. The **Support** column has to be filled in by the Member; it is taken from the ICS document. The **Test Case** identifiers refer to the name of the test case(s) for this capability/feature. The **Test Case Applicable** specifies the logical result of evaluating the values in the support column.

Item	Feature	Support Source	Support Sink	Test Case	Test Case Applicable
5.1/1 OR 6.1/1	Initiate Connection Establishment			TP/SET/BV-01-I [Est. Connect. - SRC]	
5.1/1 OR 6.1/1	Initiate Connection Establishment			TP/SET/BV-02-I [Est. Connect. - SNK]	
5.1/2O R 6.1/2	Accept Connection Establishment			TP/SET/BV-01-I [Est. Connect. - SRC]	
5.1/2 OR 6.1/2	Accept Connection Establishment			TP/SET/BV-02-I [Est. Connect. - SNK]	
5.1/3 OR 6.1/3	Initiate Start Streaming			TP/SET/BV-03-I [Start Stream. – SRC]	
5.1/3 OR 6.1/3	Initiate Start Streaming			TP/SET/BV-04-I [Start Stream. - SNK]	
5.1/4 OR 6.1/4	Accept Start Streaming			TP/SET/BV-03-I [Start Stream. - SRC]	
5.1/4 OR	Accept Start Streaming			TP/SET/BV-03-I [Start Stream. -	

6.1/4				SRC]	
5.1/5 AND 9.1.1	Send Audio Stream			TP/AS/BV-01-I [Streaming – SBC]	
5.1/5A AND 9.1.2	Send Audio Stream			*TP/AS/BV-02-I [Streaming – Options]	
6.1/5 AND 9.2/1	Receive Audio Stream			TP/AS/BV-01-I [Streaming – SBC]	
6.1/5 AND 9.2/2	Receive Audio Stream			*TP/AS/BV-02-I [Streaming – Options]	
5.1/6 OR 6.1/6	Initiate Connection Release			TP/REL/BV-01-I [Release Stream. – SRC]	
5.1/6 OR 6.1/6	Initiate Connection Release			TP/REL/BV-02-I [Release Stream. – SNK]	
5.1/7 OR 6.1/7	Accept Connection Release			TP/REL/BV-01-I [Release Stream. – SRC]	
5.1/7 OR 6.1/7	Accept Connection Release			TP/REL/BV-02-I [Release Stream. – SNK]	
5.1/8 OR 6.1/8	Initiate Suspend			TP/SUS/BV-01-I [Suspend Stream – SRC]	
5.1/8 OR 6.1/8	Initiate Suspend			TP/SUS/BV-02-I [Suspend Stream. – SNK]	
5.1/9 OR 6.1/9	Accept Suspend			TP/SUS/BV-01-I [Suspend Stream – SRC]	
5.1/9 OR 6.1/9	Accept Suspend			TP/SUS/BV-02-I [Suspend Stream. – SNK]	
6.1/10	Decode SBC			TP/SC/BV-01-C	

				[SBC Conformance – Decoder]	
5.1/10	Encoder SBC			TP/SC/BV-02-C [SBC Conformance – Encoder]	
5.2 AND 6.2	SDP features			See SDP ICS and Test Specification, [R7][R8]	
5.3 AND 6.3	GAVDP features			See GAVDP ICS and Test Specification, [R5][R9]	
*: if Optional codec or Non-A2DP codec is supported.					

9 Appendix B – Conformance Test Specification of SBC

9.1 Introduction

This conformance test specification document describes the requirements for SBC encoders, decoders and bit streams. The document consists of two test procedures:

- To test compliance to the SBC technical specification in Appendix B of A2DP[R2].
- To check the required accuracy of the output of a decoder implementation with respect to the output of a reference decoder implementation using conformance test bitstreams. [R6]

The manufacturer is requested to submit declaration that the SBC is properly implemented according to this test specification. See ICS proforma for A2DP[R4].

9.2 Symbols and Abbreviations

9.2.1 Arithmetic Operators

Operator	Description
+	Addition
-	Subtraction (as a binary operator) or negation (as a unary operator)
++	Increment
--	Decrement
*	Multiplication
^	Power
/	Division
\sqrt{x}	Square root of x

Table 9-1: Arithmetic operators

9.2.2 Relation Operators

Operator	Description
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
==	Equal to
!=	Not equal to

Table 9-2: Relation operators

9.2.3 Assignment

Operator	Description
=	Assignment operator

Table 9-3: Assignment

9.2.4 Ranges

Range	Description
[0, 10]	a number in the range of 0 up to and including 10
[0, 10>	a number in the range of 0 up to but excluding 10

Table 9-4: Ranges

9.2.5 Number Notation

Operator	Description
%X	Binary number representation (e.g. %01111100)
\$X	Hexadecimal number representation (e.g. \$7C)
X	Numbers with no prefix use decimal representation (e.g. 124.43)

Table 9-5: Relation operators

9.3 Compliance Test of SBC Bitstream Syntax

Each bitstream shall meet the syntactic and semantic requirements specified in the SBC specification document. This section describes a set of semantic tests to be performed on bitstreams. The procedure to verify whether the syntax is correct is straightforward and therefore not defined in this section. In the description of the semantic tests it is assumed that the tested bitstream contains no errors due to transmission or other causes. For each test the condition or conditions that shall be satisfied are given, as well as the prerequisites or conditions in which the test can be applied. Note that the application of these tests requires parsing of the bitstream to the appropriate levels, which in some cases goes as far as the subband samples recovery.

9.3.1 `crc_check`

The **`crc_check`** field shall contain the result of the calculation as defined in the SBC specification.

9.3.2 `RFA`

This bit is reserved for future additions and it shall contain the value 0.

9.3.3 `audio_samples[blk][ch][sb]`

Only valid codes shall be used for this field. This means that the all '1's code shall not occur.

9.3.4 `padding_bit`

These padding bits shall have the value 0.

9.3.5 `bitpool`

The combination of the values in the **`frame_header`** and the **`bitpool`** field shall not result in a bit rate higher than 320 kbps for mono streams and 512 kbps for stereo

streams. Furthermore the value of the **bitpool** field shall not exceed $16 * \text{nrof_subbands}$ for the MONO and DUAL_CHANNEL channel configurations and $32 * \text{nrof_subbands}$ for the STEREO and JOINT channel configurations.

9.4 Conformance Test

To test SBC decoders, a number of test bitstreams are supplied through web site. The details of the test sequences are listed in Tables Table 9-6 through Table 9-10. Supplied sequences cover mono and stereo signals and are provided for sampling frequencies of 16, 32, 44.1 and 48 kHz. The test set includes test sequences containing synthetic signals as well as test sequences containing speech and musical signals.

Using a supplied test sequence, a manufacturer shall test one's SBC implementation by comparing the output of a decoder under test with a reference output, or the output of a reference decoder. Details of the test procedure are described below in Section 9.4.1. Software is provided for performing this verification procedure.

9.4.1 Test procedures for SBC decoder

All measurements are carried out relative to full scale where the output signals of the decoder and supplied test sequences are normalised to be in the range between -1.0 and +1.0.

The test sequences have a precision (P) of 16 bits, where the most significant bit (MSB) shall be labelled bit 0 and the least-significant bit (LSB) shall be labelled bit 15. The most significant bit (bit 0) represents the value of -1; the second most significant bit (bit 1) represents the value of +1/2, etc.

$$\begin{aligned}
 \text{value of bit 0 (MSB)} &= -\frac{1}{2^0} = -1 \\
 \text{value of bit 1} &= \frac{1}{2^1} = \frac{1}{2} \\
 \text{value of bit 2} &= \frac{1}{2^2} = \frac{1}{4} \\
 &\vdots \\
 &\text{M} \\
 \text{value of bit 15 (LSB)} &= \frac{1}{2^{15}} = \frac{1}{32768}
 \end{aligned}$$

The output signal of the decoder under test is required to be in the same format. In the next step, the difference (*diff*) of the samples of these signals shall be calculated. Every channel of the bitstream shall be tested. The total number of samples for each channel is *N*.

$$\text{Diff}(n) = \text{Out}(n) - \text{Seq}(n), \text{ for } n=1 \text{ to } N,$$

Where $Out(n)$ denotes output signal of decoder under test, and $Seq(n)$ denotes supplied test sequence.

The values of all difference samples shall be squared, summed, divided by N and then the square-root shall be calculated. This calculation finally gives the rms level.

$$rms = \sqrt{\frac{1}{N} \sum_{n=1}^N diff(n)^2}$$

To fulfil the RMS/LSB Measurement test at an accuracy level of K bit, an SBC decoder shall provide an output waveform such that the RMS level of the difference signal between the output of the decoder under test and the output of the reference decoder is less than $1/(2^{(K-1)} \cdot 12^{0.5})$. In addition, the difference signal shall have a maximum absolute value of at most $1/2^{(K-2)}$ relative to full-scale. The RMS/LSB Measurement test shall be carried out for an accuracy level of $K=14$ bit unless a different accuracy level is explicitly stated.

9.4.2 Description of the SBC test bitstreams

9.4.2.1 Configuration Tests

The configuration test sequences in Table 9-6 are mainly intended for testing the compliant support of the different configuration settings of SBC bitstreams.

Sequence (sbc_test_xx)	01	02	03	04	05	06	07	08
Subbands	4	4	8	8	8	8	4	4
Block length	16	16	8	8	4	4	12	12
Sampling frequency (kHz)	48	48	44.1	44.1	32	32	16	16
Channel mode	M	D	M	J	M	S	M	J
Allocation method (S=SNR,L=LOUDNESS)	S	S	L	L	S	S	L	L
Bitpool	18	16	32	56	24	48	20	42
Content (M=Music,S=Speech)	M	M	M	M	M	M	S	M
Number of frames	2250	2250	2067	2067	3000	3000	1000	1000
Resulting frame length (Bytes)	42	72	40	69	20	36	36	72
Resulting bit rate (kbps)	252	432	221	381	160	288	96	192

Table 9-6: Configuration tests

9.4.2.2 VBR Tests

The VBR test sequences in Table 9-7 are intended for testing the switching of the bitpool value of SBC bitstreams. In the first sequence, sbc_test_09, switching of the bitpool value between 14 and 15 is used to obtain a bit rate of exactly 192 kbps, whereas using a bitpool value of 14 would result in 187.425 kbps and a bitpool value of 15 would result in 198.45 kbps. In the second sequence the bitstream starts with a bitpool value of 31, resulting in 240 kbps and after one second the bitstream value switches to 51, resulting in a change to 360 kbps, at two seconds the bitpool value changes back to the value of 31.

Sequence (sbc_test_xx)	09	10
Subbands	4	8
Block length	16	12
Sampling frequency (kHz)	44.1	48
Channel mode	M	J
Allocation method (S=SNR,L=LOUDNESS)	L	L
Bitpool	14,15	31,51
Content (M=Music,S=Speech)	M	M
Number of frames	2067	1500
Resulting frame lengths (Bytes)	34,36	60,90
Resulting av. bit rate (kbps)	192	280

Table 9-7: VBR tests

9.4.2.3 Maximum Bit Rate Test

The maximum bit rate sequences in Table 9-8 are provided to test whether the decoder supports the maximum bit rate for each sampling frequency.

Sequence (sbc_test_xx)	11	12	13	14	15	16	17	18
Subbands	8	8	8	8	8	8	8	8
Block length	16	16	16	16	16	16	16	16
Sampling frequency (kHz)	16	16	32	32	44.1	44.1	48	48
Channel mode	M	J	M	J	M	J	M	J
Allocation method (S=SNR,L=LOUDNESS)	L	S	L	S	L	S	L	S
Bitpool	128	249	76	121	54	86	49	78
Content (M=Music,S=Speech)	M	M	M	M	M	M	S	M
Number of frames	375	375	750	750	1033	1033	1125	1125
Resulting frame length (Bytes)	264	511	160	255	116	185	106	169
Resulting bit rate (kbps)	264	511	320	510	320	510	318	507

Table 9-8: Maximum bit rate tests

9.4.2.4 Special Test

The special test sequences are designed such that a large number of possible bitstream-parameter combinations are present

Sequence (sbc_test_xx)	19	20
Subbands	8	8
Block length	16	16
Sampling frequency (kHz)	48	44.1
Channel mode	M	J
Allocation method (S=SNR,L=LOUDNESS)	S	S
Bitpool	29	53
Content (B=Block wave sweep,S=Sine wave sweep)	B	S
Number of frames	1152	768
Resulting frame length (Bytes)	66	119
Resulting bit rate (kbps)	198	328

Table 9-9: Special tests

9.4.2.5 Typical Test

The typical test sequences are designed such that the typical use of parameters can be tested.

Sequence (sbc_test_xx)	21	22	23	24	25	26	27	28
Subbands	8	8	8	8	8	8	8	8
Block length	16	16	16	16	16	16	16	16
Sampling frequency (kHz)	44.1	48	44.1	48	44.1	48	44.1	48
Channel mode	M	M	J	J	M	M	J	J
Allocation method (S=SNR,L=LOUDNESS)	L	L	L	L	L	L	L	L
Bitpool	19	18	35	33	31	29	53	51
Content (M=Music,S=Speech)	M	M	M	M	M	M	M	M
Number of frames	1033	1125	1033	1125	1033	1125	1033	1125
Resulting frame length (Bytes)	46	44	83	79	70	66	119	115
Resulting bit rate (kbps)	127	132	229	237	193	198	328	345

Table 9-10: Typical tests

9.4.3 Test procedures for SBC encoder

The SBC encoder shall comply with the following two requirements

- Its output shall be compliant with SBC bitstream syntax.
- The subjective quality (measured by standardized way or by objective testing methods, see [R10] and [R11]) shall be equivalent to that of reference encoder.

9.4.4 Reference SBC Encoder and Decoder

Reference executables for the Win32 platform are available of both the encoder and the decoder of the SBC codec. In this section the usage of these programs is explained. By typing 'sbc_encoder -h' and 'sbc_decoder -h', the usage can also be displayed.

The SBC codec can operate at four sampling frequencies: 16, 32, 44.1 and 48 kHz. The sampling frequency is obtained from the encoder input file. This input file shall therefore be in one of the following formats: aiff, sun/next or wave.

9.4.4.1 Reference SBC Encoder Version 1.5

Usage:

```
sbc_encoder [-jsv] [-lblk_len] [-nsubbands] [-p] [-rrate] [-ooutputfile] inputfile
    [-s] use the stereo mode for stereo signals
    [-v] verbose mode
    [-j] enables the use of joint coding for stereo signals
    [-lblk_len] blk_len specifies the APCM block length, out of [4,8,12,16]
    [-nsubbands] subbands specifies the number of subbands, out of [4,8]
    [-p] a simple psycho acoustic model is used (preferred)
    [-rrate] specifies the bit rate in bps
    [-ooutputfile] specifies the name of the bitstream output file inputfile
    specifies the audio input file, the major audio formats are supported
```

Example:

```
sbc_encoder -j -n8 -l16 -p -r279000 -ofile.sbc file.wav
```

9.4.4.2 Reference SBC Decoder Version 1.5

Usage:

```
sbc_decoder [-v] [-ooutputfile] [-pstartpos] inputfile
    [-v] verbose mode
    [-pstartpos] startpos specifies the byte offset to start with decoding
    [-ooutputfile] specifies the name of the audio output file inputfile
    specifies the name of the bitstream input file
```

Example:

```
sbc_decoder -ofile.sbc_dec file.sbc
```

10 Appendix C – Acronyms and Abbreviations

Acronym	Description
A2DP	Advanced Audio Distribution Profile
ACP	Acceptor
DPIT	Designated Profile Interoperability Tester
INT	Initiator
PDU	Protocol Data Unit
PRD	Qualification Program Reference Document
SBC	Low Complexity Subband Codec
SNK	Sink
SRC	Source
TP	Test Purpose
TSS	Test Suite Structure