High-Definition Multimedia Interface

Compliance Test Specification

Version 1.3b

Hitachi, Ltd.

Matsushita Electric Industrial Co., Ltd.

Philips Consumer Electronics, International B.V.

Silicon Image, Inc.

Sony Corporation

Thomson Inc.

Toshiba Corporation

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Preface

Notice

Document Revision History

1.3b	2007/03/26	Modifications to TE overview and policy description (4.1) Addition of Agilent TDR to Recommended TE (4.2.1.11) Clarification of tentative cable emulators (4.2.1.17) Jitter tolerance test changes (8-7) Added cable tests for TMDS_CLOCK channel (5-3) New VL triggering (7-2) Editorial and clarifications on CEC Line Degradation (7-15, 8-14) Added testing of additional source-supported Deep Color formats (7-34) Additional HDMI VSDB EDID checks (8-3) Additional TTC usage (5-3, 8-5, 8-6, 8-7) Incorporated Tek-recommended setup and calibration for TDR (8-8) Clarification on Sink Deep Color Recommended Test Method (8-25) Added long cable or cable emulator use for Repeater test (9-3) Added color-depths for each format in Source_Video_Formats (App. 3) Removed test for filler bytes (8-3) Removed Tektronix part number of cable emulator EFF-HDMI-CE-01
1.3a	2006/11/10	Clarified pixel clock vs. TMDS clock (throughout). Added new test equipment and test fixtures from Agilent and Tektronix for high-speed testing (throughout) Added Reference Cable Equalizer to eye analysis equipment and tests. Added tests and test equipment capabilities for 1.3 features (Deep Color, cable categories, xvYCC, HBRA, Type C connector) Added testing of 1080p 50Hz/60Hz in various tests. Added Transition Time Control (TTC) equipment and usage (5-3, 8-7) Allowed use of any sufficient multi-meter, I^2C analyzer and power supply. Added preliminary cable phase measurements for passive-equalized cables per HDMI 1.3a (5-7) Relaxed impedance requirements with 250ps excursion window as specified in HDMI 1.3a (5-8, 8-8) Added preliminary active cable test (5-9) Modified V_L limits, per HDMI 1.3 and 1.3a (7-2) Removed max rise/fall time limit, per HDMI 1.3a (7-4) Removed Source Overshoot/Undershoot test (7-5) Added 20-bit trigger sequence for Inter-Pair skew check (7-6) Removed erroneous check of CLOCK in Inter-Pair skew check (7-7) Set jitter measurement window at 0V (7-9) Clarified which frequencies to test for jitter and eye (7-9, 7-10, 8-7). Changed CEC capacitance limits, per HDMI 1.3a (7-13, 8-9) Added check for new AVI InfoFrame fields (7-27) Added optional testing of jitter injected onto TMDS_DATA (8-7) Perform HPD voltage in both standby and off (8-10) Eliminated VGA Established Timings check (8-20) Degraded input signal used for Repeater output test (9-1) Added check of Physical Address-related CDF fields (9-5) Added HDCP testing requirements (section 1).

1.2a	2005/12/15	Incorporation of Quantum Data 882 for CEC and EDID tests (sects. 4.2.1.1.9, 4.2.3.1, 4.2.3.2, Appendix 1) Add note regarding discontinued test equipment (sect.4.1.1) Added General Oscilloscope (4.2.3.4) New policy – submit all longer cable length (sect. 5 first paragraph) Clarified extent of overmold restriction (5-1) Restricted cable power consumption to 5mA (5-3) Clarified use of Tektronix TDR (5-8, 8-8) Clarified policy – all connectors must be tested and results submitted (sect. 6 intro) Addressed capacitance measurement issues with TE and configuration change (7-13, 8-9) Replaced I_{OFF} test with V_{OFF} test (7-3) Adjusted HPD voltages per HDMI Spec (7-12) Verify legal usage of “independent CEC” function (7-14, 8-13) Adjusted CEC resistance allowance per HDMI Spec (7-14, 8-13) Adjusted CEC degradation check (7-15, 8-14) Removed Type A-related test (7-20) Verify compliance with audio-must-output rule (7-28) Changed audio/video format combinations to test (7-30) Added max differential test and adjusted max V_{ICM} (8-5) Added new video formats (7-25, 7-26, 8-17) Removed DTD requirement per HDMI Spec (8-17) Clarified variety of TE specs (4.2.1.5, 4.2.1.9, 4.2.1.11, 4.2.1.16, 4.2.3.3, Clarified test methods and configurations (7-1, 7-3, 7-5, 7-6, 7-7, 7-11, 7-13…18, 7-23…33, 8-1…3, 8-5, 8-7, 8-9, 8-14, 8-16…23, 9-1…9-5) Numerous clarifications in CDF fields (Appendix 3)
1.1	2004/06/04	Clarified Multi-meter vs. Voltage meter usage (throughout). Changed to SMA version of differential probe (sect. 4.2.1.5, 7-5, 7-10). Clarified test conditions and procedures (5-3, 7-10, 7-23, 7-24, 7-25, 7-27, 7-29, 7-31, 8-7, 8-15, 8-17). Added testing of Type B connectors (5-1). Clarified testing of active, unidirectional cables (5-2). Clarified use of serial pattern trigger (7-6). Changed limits of +5V Power Signal [per HDMI 1.1 change] (7-11). Changed test conditions for DDC/CEC capacitance (7-13, 8-9). Simplified/clarified testing of CEC connectivity (7-14, 8-13). Added test conditions for CEC degradation (7-15, 8-14). Added tests for additional CTLx restrictions (7-17). Added tests for new HDMI 1.1 packets (7-19). Modified test requirements and methods for AVI check (7-27). Added check for channel status indication of Fs (7-28). Added check for extended HDMI VSDB handling (7-33). Verify HDMI VSDB extension fields [new in HDMI 1.1] (8-3). Clarified initialization procedure and failure conditions (8-7). Changed limits of HPD voltage and test conditions [per HDMI 1.1 change] (8-10). Clarified testing of HPD for non-ordinary circumstances (8-11). Add testing for new Supports_AI capability [HDMI 1.1] (8-16). Clarified EDID use and test of 640x480p format (8-20). Swapped tests to correct positions (9-2, 9-4). Updated ATC test equipment lists for new and evaluation TE (App. 1).

		Updated CDF with new fields for HDMI 1.1 and new tests (App. 3) Many editorial changes throughout.
1.0a	2003/07/22	Fix table in Test 7-22
1.0	2003/07/18	1.0 Release
0.9	2003/06/26	0.9 Release

Table of Contents

1 Introduction

1.1 Purpose and Scope

This document constitutes the specification of procedures, tools and criteria for testing the compliance of devices with the High-Definition Multimedia Interface Specification Version 1.3a.

Each individual test is designed to ensure compliance with one or more requirements in the HDMI Specification or in one of its normative (required) specifications. No amount of testing can guarantee 100% interoperability among all passing devices when operated in all possible modes but, properly executed, the tests described in this document should give a very high level of confidence in the ability of the device to interoperate with other HDMI devices.

Due to the nature of testing a closed-box system such as a TV or DVD player, there are a variety of requirements in the HDMI Specification which are very difficult or impossible to directly verify. Compliance testing for these items will depend upon alternative methods, which may not have 100% correlation with the HDMI-required behavior but will achieve the objective of generating confidence in the interoperability of the device.

Consumer Electronics Control (CEC) test methods are given in the HDMI Compliance Test Specification Supplement 1.

Type B and dual-link functionality is not fully covered by this test specification. Such details will be included in a future version.

1.2 Normative References

HDMI Licensing, LLC., "High-Definition Multimedia Interface, Specification Version 1.3a", November, 10, 2006, ("HDMI 1.3a")

DCP, LLC, "High-bandwidth Digital Content Protection Specification, Compliance Test Specification, Revision 1.1", June 14, 2006 (http://www.digital-cp.com)

Note that the HDMI Specification includes normative references affecting the required operation of HDMI devices.

1.3 Organization of this document

This specification is organized as follows:

- Chapter 1 describes the Purpose and Scope of the document, references, usages and conventions.
- Chapter 2 defines terms and acronyms used within the document.
- Chapter 3 provides an Overview to HDMI compliance testing.
- Chapter 4 describes the Required Capabilities for the defined test equipment as well as certain Recommended Test Equipment that has been proven to meet those requirements.
- Chapter 5 describes the tests for a Cable Assembly. For each test, a Required Test Method is described that defines the minimum requirements for accurate and valid testing and a Recommended Test Method that describes the specific procedure for the use of specific test equipment known to adequately test for the required condition.
- Chapter 6 describes the tests for Plug and Receptacles used on any HDMI product.

- Chapter 7 describes the tests for a Source.
- Chapter 8 describes the tests for a Sink
- Chapter 9 describes the tests for a Repeater.
- Chapter 10 describes HDCP testing requirements.
- Appendix 1 lists the test equipment used by the Authorized Testing Centers.
- Appendix 2 describes the Software CRU technology used during TMDS electrical testing.
- Appendix 3 defines the Capabilities Declaration Form, which is filled out and submitted by the product manufacturer whenever a product is sent for testing at an Authorized Testing Center (ATC) or when the results of ATC or self-testing are sent to the HDMI Licensing, LLC.
- Appendix 4 defines the Test Results Form, which is completed by the test operator and submitted as the results of ATC or self-testing to the HDMI Licensing, LLC.
- Supplement 1: CEC, defines the tests for the optional Consumer Electronics Control protocol.

2 Definitions

2.1 Conformance Levels

expected	A key word used to describe the behavior of the hardware or software in the design models *assumed* by this specification. Other hardware and software design models may also be implemented.
may	A key word that indicates flexibility of choice with *no implied preferenc*e.
shall	A key word indicating a mandatory requirement. Designers are *required* to implement all such mandatory requirements.
should	A key word indicating flexibility of choice with a strongly preferred alternative. Equivalent to the phrase *is recommended*.

2.2 Usages and Conventions

Note that the HDMI Specification should be referenced for definitions of all usages and conventions that are not defined below.

bit N	Bits are numbered in little-endian format, i.e. the least-significant bit of a byte or word is referred to as bit 0.
D[X:Y]	Bit field representation covering bit X to bit Y (inclusive) of value or field D.
0xNN	Hexadecimal representation of base-16 numbers are represented using ‘C’ language notation, preceded by ‘0x’.
0bNN	Binary (base-2) numbers are represented using ‘C’ language notation, preceded by ‘0b’.
NN	Decimal (base-10) numbers are represented using no additional prefixes or suffixes.
!=	Does not equal (‘C’ notation).
==	Is Equal to (‘C’ notation). Used to test for a specific value (e.g. if bit 3 == 1, or, verify that byte SB0 == 0).
=	Equals (‘C’ notation). Used to assign a value to a variable (e.g. number of packets = number of pixels / 32) or is used in the specification of a required value (e.g. AVcc = 3.3V ±5%).
[HDMI: X.Y.Z]	Shorthand notation indicating a reference to the HDMI Specification. Examples: [HDMI: 3.2] denotes a reference to the HDMI Specification, section 3.2.
[CEC: X.Y.Z]	Denotes a reference to the HDMI Specification, Supplement 1, “Consumer Electronics Control”, section CEC X.Y.Z.
[861-D: X.Y.Z]	Denotes a reference to the CEA-861-D specification. Examples: [861-D: 3.2] denotes a reference to the CEA-861-D specification, section 3.2.

[comment]	Informative comment describing subsequent normative test step.
TMDS_DATA0	Equivalent to the differential signal pair TMDS Data0. When referring to a single-ended signal within this pair, TMDS_DAT0+ or TMDS_DATA0– is used. Same applies to TMDS_DATA1, TMDS_DATA2 and TMDS_CLOCK.
FAIL, “xxx”	Indicates a directive to the test operator to fail this test and to write “FAIL” in the “Pass/Fail” field of the Test Results form, and the comment “xxx” in the Comments field. It is permitted and frequently useful for the remainder of the test to be performed to provide additional information about the failure.
PASS, “xxx”	Indicates a directive to the test operator to pass this test and to write “PASS” in the “Pass/Fail” field of the Test Results form, and the comment “xxx” in the Comments field. The PASS directive indicates that the test is complete unless indicated otherwise. There is an implied PASS directive at the end of every test method, causing successfully completed tests to PASS.

2.3 Glossary of Terms

Note that the HDMI Specification should be referenced for definitions of any terms that are not defined below.

CEA format	Also called CEA-861-D-defined video format. Any video format listed in CEA-861-D for which a Video Identification Code exists.
test coupon	A test trace, that emulates the signal traces, present on a test fixture PCB. The test coupon is used to measure and compensate for process variations during PCB manufacture.
support	The ability for a device to perform the appropriate action (for that device) with the specified format or option. For display devices, a video format is supported if such a signal is displayed in a manner comparable to other video formats or video from other inputs. For source devices, a video format is supported if the device is capable, after appropriate user input or delivery of appropriate content to the device, of outputting a signal with that format.
T_{BIT}	One bit time at the specified TMDS clock frequency (= $T_{CHARACTER}$/10). If no TMDS clock frequency is specified, it is assumed to be the current (tested) TMDS clock frequency.
$T_{CHARACTER}$	One character time at the specified (TMDS) clock frequency. If no TMDS clock frequency is specified, it is assumed to be the current (tested) TMDS clock frequency. If a video format is pixel-repeated, $T_{CHARACTER}$ continues to be defined as 10* T_{BIT}.

2.4 Acronyms and Abbreviations

Note that the HDMI Specification should be referenced for definitions of any terms that are not defined below.

ATC	Authorized Testing Center
CDF	Capabilities Declaration Form
DTD	Detailed Timing Descriptor (also called “18-byte timing descriptor”)
DUT	Device Under Test
ISVM	I (current) Source Voltage Measurements
SVD	Short Video Descriptor (in Data Block collection of CEA EDID Timing Extension)
TDR	Time Domain Reflectometer/Reflectometry
TDT	Time Domain Transmission
TE	Test Equipment
TPA	Test Point Access
VSIM	Voltage Source I (current) measurements

3 Overview

HDMI system architecture is defined to consist of Sources, Sinks, Repeaters and Cable Assemblies. A given device may have one or more HDMI inputs and one or more HDMI outputs. Each HDMI input on a device shall follow all of the rules for an HDMI Sink and each HDMI output shall follow all of the rules for an HDMI Source. Consequently, each HDMI input shall be fully tested for compliance using the tests specified for Sink devices and each HDMI output shall be fully tested against the full set of tests specified for Source devices.

Any device with at least one HDMI input and at least one HDMI output is defined to be a Repeater. In addition to the Source and Sink tests required for each of the inputs and outputs, additional Repeater tests may be required.

In addition to the tests described for Sources, Sinks, Repeaters and Cable Assemblies, there are tests described for connectors present on these devices. The manufacturer of the device is required to verify the compliance of the connector in all cases, whether the product is ATC-tested or self-tested.

In order to provide the best coverage possible, it is necessary to perform many of the tests herein for each relevant operational mode of the Device Under Test (DUT). For instance, it is necessary to perform some of the video tests for each supported video format timing.

The primary purpose of the testing is to reveal whether the product passes all test cases. A failure of a single test item within a test case constitutes a failure of the product to meet the overall compliance testing requirement. However, even if an intermediate test step within a test case reveals a failure, it is permitted and frequently useful for the remainder of that test case and other test cases to be performed in order to provide additional information about the failure.

4 Test Equipment

4.1 Test Equipment Overview and Policy

4.1.1 Required Capabilities versus Recommended Equipment

Each piece of test equipment referenced by the individual test cases in the Source, Sink, Repeater and Cable Assembly sections is listed below. For each of these, the “Required Test Equipment Capabilities” are described. All equipment used for testing the related attributes shall comply with the requirements listed for that equipment.

In addition, for each of the defined pieces of equipment, specific commercial or custom “Recommended Test Equipment" is described. This includes the primary equipment that is used in the HDMI Authorized Test Centers and should also, if possible, be used for any self-testing of the related functions. An equivalent successor to the recommended test equipment may be used as a replacement. Adopters and ATCs should contact the recommended test equipment maker to learn which products are equivalent replacements. Other configurations and equipment may be used for self-testing, as long as that equipment and the processes used meet all of the stated and implied requirements and permit an equivalent level of testing. It is the Adopter’s responsibility to verify that the substituted equipment and processes are sufficient.

Adopter should understand that HDMI Licensing, LLC, the HDMI Founders and the test equipment maker may not ensure the future commercial availability of the “Recommended Test Equipment”.

4.1.2 Analyzers and Generators

In general, Source devices are tested using various Sink emulators with measurement functions, typically called “Analyzers”. These Sink emulators may have a variety of EDID structures used to encourage certain behavior by the Source DUT and they are capable of measuring a variety of parameters or attributes of the HDMI signals delivered by the Source DUT. The measurement may be performed using the facilities of the Sink emulator itself or using standard test equipment such as digital oscilloscopes, logic analyzers or network analyzers.

Likewise, Sink devices are tested using a variety of Source emulators or “Generators” capable of generating a variety of test signals. These generators may consist of custom hardware designed for HDMI compliance testing or may consist of standard waveform and pattern generators or some combination thereof.

4.1.3 Simultaneous Test Case Execution

Some test tools can be used for a variety of test cases. These tests can sometimes be executed simultaneously so that, with one running of the tool, several tests can be passed or failed without re-running the tool.

4.2 Test Equipment Requirements

All test equipment requiring calibration in order to ensure accurate and repeatable results shall be calibrated prior to and, if necessary, during the test procedure.

4.2.1 Electrical Testing

4.2.1.1 Test Point Access Boards

4.2.1.1.1 Overview

In order to gain access to the required signals, a variety of Test Point Access boards are required, each tailored for a particular test purpose. TPA boards provide test points for the pins on the HDMI connector.

For each of the different connector types there are two classes of TPA fixtures. These are the Receptacle TPA (TPA-R) and Plug TPA (TPA-P). A TPA-P is typically used for Source and Sink tests and one or two TPA-R are used for cable tests. In addition, A TPA-R is sometimes used to calibrate the test signal meant to be delivered to a Sink DUT.These boards permit direct access to all TMDS, DDC and CEC signals. Due to the variety of measurements taken (e.g. skew, jitter) and the types of probes used, several TPA boards are needed for each connector type (Plug and Receptacle).

When a TPA board is acting as a Sink (for Source DUT testing), additional functionality may be required. If appropriate termination resistors are not integrated into the probes used then such resistors must be connected between each TMDS signal and a (typically) 3.3V supply. In addition, a variety of EDID images may be required in order to get the Source to create the required signal. For this reason, an EDID Emulator may need to be attached to the TPA board. Lastly, as a Sink, the TPA is typically operated with the Hot Plug Detect signal connected to the +5V Power signal through a 1.2kΩ resistor.

Required Test Equipment Capabilities

Following are the capabilities common among all of the TPA boards:

- HDMI plug or receptacle is mounted in such a way to enable direct connection to a Source, Sink or Cable Assembly. This includes being able to attach the assembly in tight or awkward locations such as within a connector access panel at the rear of a flat panel display.
- Termination: On some TPAs that are used to emulate the behavior of a Sink, termination resistors are provided on each of the TMDS signal lines. In this case:
  - Connector is provided allowing input of external DC 3.3V source to +3.3V power rail used for TMDS termination.
  - Test point is provided on 3.3V rail.
  - Each single-ended TMDS signal is pulled up to +3.3V power rail through a 50Ω resistor with less than ± 1% tolerance.
  - Test coupon test ports (see below) are pulled up to the +3.3V rail through a 50Ω resistor with less than ± 1% tolerance. At least 1 GND pin is mounted near the test port (closer than 15mm).
- All TMDS signals have the following characteristics:
  - Test port shall be appropriate to the type of probe used and is located at an equivalent trace length from the HDMI connector as all other test ports.
  - Characteristic differential impedance of the connector, for each differential TMDS pair is 100Ω ± 15%.

- Characteristic differential impedance of the leads (cables or traces), for each differential TMDS pair, is 100Ω ± 5% as a average over the entire trace. Peak impedance of up to 100Ω ±10% is also permitted.
- Intra-pair skew is less than 15psec.
- Inter-pair skew is less than 40psec.
- If TPA is PCB-based, then at least 1 GND pin is mounted near each TMDS test port. This pin is connected to the PCB ground plane as well as to all of the TMDS shields.

❑ Non-TMDS pins (if required for test):

- These pins have testing ports that can be used to measure or drive each of the signals.
- Connector is provided to allow input of DC 5V to the HDMI +5V Power pin.
- HDMI HPD signal may be connected to HDMI +5V Power through a removable 1.2kΩ resistor.

❑ If TPA is PCB-based, then it is recommended that a test coupon be provided to measure and compensate for process variation of PCB manufacture:

- Test coupon consists of one or two traces meant to emulate the traces of a single-ended TMDS signal or a differential pair of TMDS signals.
- Each of the traces is located on the same layer of the PCB as the trace that it is emulating.
- Trace length and characteristics are equivalent to that of the emulated trace on this board.
- To enable easy and accurate attachment of testing equipment, each trace is terminated at one end to an SMA connector (or other connector of sufficient quality) and at the other with a Test port, which is identical to the Test ports for the TMDS signals and designed to match the probes used for the measurement.

4.2.1.1.2 TPA-P for Differential measurement

Access points are provided for differential probes to measure each of the four TMDS differential pairs.

<u>Required Test Equipment Capabilities</u>

- All standard TPA capabilities described above in Section 4.2.1.1.1.
- Plug connector is mounted to enable direct connection to a Source or Sink.
- TMDS test ports consist of two pins (for each TMDS differential pair) designed to allow direct and reliable connection of a differential probe.
- Test coupon consists of two traces as described in Section 4.2.1.1.1 with test ports identical to those on the TMDS traces.

<u>Recommended Test Equipment – For use with Tektronix P7330 Probe and at TMDS clock frequencies less than or equal to 74.25MHz</u>

- Tektronix TPA-P-DI, available as one component in Tektronix 013-A013-50

4.2.1.1.3 TPA-R for Differential measurement

Access points are provided for differential probes to measure across each of the four TMDS differential pairs.

Required Test Equipment Capabilities

- All standard TPA capabilities described above in Section 4.2.1.1.1.
- Receptacle connector is mounted to allow direct connection to a Cable Assembly.
- TMDS test ports consist of two pins (for each TMDS differential pair) designed to allow direct and reliable connection of a differential probe.
- Test coupon consists of two traces as described in Section 4.2.1.1.1 with test ports identical to those on the TMDS traces.

Recommended Test Equipment – For use with Tektronix P7330 Probe and at TMDS clock frequencies less than or equal to 74.25MHz

- Tektronix TPA-R-DI, available as one component in Tektronix 013-A012-50

4.2.1.1.4 TPA-P for Single Ended measurement

Access points are provided for single-ended probes to measure each of the TMDS single-ended signals.

Required Test Equipment Capabilities

- All standard TPA capabilities described above in Section 4.2.1.1.1.
- Plug connector is mounted to allow direct connection to a Source or Sink.
- TMDS test ports consist of two pins (for each TMDS single-ended signal) designed to allow direct and reliable connection of a single-ended probe with corresponding ground connection.
- Test coupon consists of one trace as described in Section 4.2.1.1.1 with test port identical to those on the TMDS traces.

Recommended Test Equipment – For use with Tektronix P7240 Probe and at TMDS clock frequencies less than or equal to 74.25MHz

- Tektronix TPA-P-SE, available as one component in Tektronix 013-A013-50

4.2.1.1.5 TPA-R for Single Ended measurement

Access points are provided for single-ended probes to measure each of the TMDS single-ended signals.

Required Test Equipment Capabilities

- All standard TPA capabilities described above in Section 4.2.1.1.1.
- Receptacle connector is mounted to allow direct connection to a Cable Assembly.

- TMDS test ports consist of two pins (for each TMDS single-ended signal) designed to allow direct and reliable connection of a single-ended probe with corresponding ground connection.
- Test coupon consists of one trace as described in Section 4.2.1.1.1 with test port identical to those on the TMDS traces.

<u>Recommended Test Equipment – For use with Tektronix P7240 Probe and at TMDS clock frequencies less than or equal to 74.25MHz</u>

- Tektronix TPA-R-SE, available as one component in Tektronix 013-A012-50

4.2.1.1.6 TPA-P with SMA Connection

This TPA is typically used in a manner that emulates a Source device, rather than a Sink device. Access points are provided for driving each of the TMDS signals.

<u>Required Test Equipment Capabilities</u>

- All standard TPA capabilities described above in Section 4.2.1.1.1.
- Plug connector is mounted to allow direct connection to a Source or Sink.
- TMDS test ports consist of one SMA connector for each TMDS signal and are designed to allow easy connection of any SMA connection.
- There are no TMDS pull-up resistors installed.
- Can support a TDR-effective rise time of less than 200psec (10-90%), when connected to the TDR oscilloscope..
- Test coupon consists of one trace as described in Section 4.2.1.1.1 with test port identical to those on the TMDS traces (SMA).

<u>Recommended Test Equipment #1 – For use at TMDS clock frequencies less than or equal to 74.25MHz</u>

- Tektronix TPA-P-TDR, available as one component in Tektronix 013-A013-50

<u>Recommended Test Equipment #2 – For use at any TMDS clock frequency</u>

- Agilent N1080A Opt H01 TPA-Plug & Opt H03 TPA-Control
- Agilent N5380A TPA-SMA termination and probe head

<u>Recommended Test Equipment #3 – For use any TMDS clock frequency</u>

- EFF-HDMI-TPA-P available from Efficere Technologies as part of set ET-HDMI-TPA-S.

4.2.1.1.7 TPA-R with SMA Connection

This TPA is typically used in a manner that emulates a Source device, rather than a Sink device. Access points are provided for driving each of the TMDS signals.

<u>Required Test Equipment Capabilities</u>

- All standard TPA capabilities described above in Section 4.2.1.1.1.
- Receptacle connector is mounted to allow direct connection to a Cable Assembly.

- TMDS test ports consist of one SMA connector for each TMDS signal and are designed to allow easy connection of any SMA connection.
- There are no TMDS pull-up resistors installed.
- Can support a TDR-effective rise time of less than 200psec (10-90%), when connected to the TDR oscilloscope.
- Test coupon consists of one trace as described in Section 4.2.1.1.1 with test port identical to those on the TMDS traces (SMA).

Recommended Test Equipment #1 – For use at TMDS clock frequencies of 74.25MHz or lower

- Tektronix TPA-R-TDR, available as one component in Tektronix 013-A012-50

Recommended Test Equipment #2 – For use at any TMDS clock frequency

- Agilent N1080A Opt H02 TPA-Receptacle & Opt H03 TPA-Control
- Agilent N5380A TPA-SMA termination and probe head

Recommended Test Equipment #3 – For use with any SMA probe at any TMDS clock frequency

- EFF-HDMI-TPA-R with EFF-E-EDID-TPA (EDID/Control breakout adapter), available from Efficere Technologies as part of set ET-HDMI-TPA-S.

4.2.1.1.8 TPA-R for Network Analyzer measurement (TPA-R-NA)

This TPA is typically used in a manner that emulates a Source device, rather than a Sink device. Access points are provided for driving each of the TMDS signals.

Required Test Equipment Capabilities

- ❑ All standard TPA capabilities described above in Section 4.2.1.1.1.
- ❑ Receptacle connector is mounted to allow direct connection to a Cable Assembly.
- ❑ TMDS test ports consist of one SMA connector for each TMDS signal and are designed to allow easy connection of a Network Analyzer.
- ❑ Measurement bandwidth is 300kHz - 4.125GHz
- ❑ Test coupon is preferred but not required.

Recommended Test Equipment #1

- ADVANTEST CAX-ATI013

Recommended Test Equipment #2

- Agilent N1080A Opt H02 TPA-Receptacle

4.2.1.1.9 TPA-CEC-R – Quiescent CEC Electrical Test Fixture

Required Test Equipment Capabilities

- Test pin to measure the voltage of CEC line
- Following connection capability is necessary
  - Connect CEC line to DDC/CEC Ground via a 1Mohm ±5% resistor

- Connect CEC line to 3.3V via a 27kohm ±5% resistor
- Connect CEC line to 3.3V via a 27kohm ±5% resistor and to DDC/CEC Ground via 1kΩ ±5%
- Connect CEC line to 3.63V via a 27kohm ±5% resistor

Recommended Test Equipment #1

- Quantum Data TPA-CEC-R
  - Connect CEC line to DDC/CEC Ground via a 1Mohm ±5% resistor (Position 1)
  - to 3.3v via a 27kohm ±5% resistor (Position 3)
  - to 3.3v via a 27kohm ±5% resistor and to DDC/CEC Ground via 1kΩ ±5% (Position 4)
  - Connect CEC line to 3.63V via a 27kohm ±5% resistor (Position 5)

Recommended Test Equipment #2

- Agilent N1080A Opt H03 TPA-Control

4.2.1.2 Jitter/Eye Analyzer

All jitter and eye measurements are taken relative to a Recovered Clock which is generated by a Clock Recovery Unit (CRU). This recovered clock is meant to approximate the Ideal Recovery Clock specified in the HDMI Specification. This Recovered Clock, rather than the real TMDS differential clock, is used as the trigger for measurement of the TMDS clock jitter and TMDS data eye diagram.

Figure 4-1 shows *functionally* how the CRU is used to measure an eye diagram. Clock jitter is measured using a very similar approach, shown in Figure 4-2. Effectively, the CRU generates the trigger that the oscilloscope uses to capture and display the data eye. Figure 4-2 shows how the CRU is used to measure the jitter on a transmitted TMDS clock.

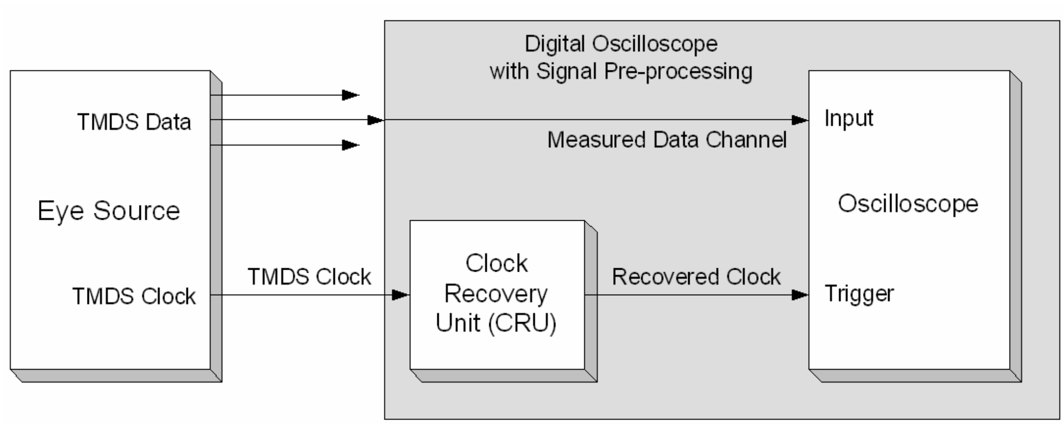


Figure 4-1 TMDS Eye Diagram Measurement

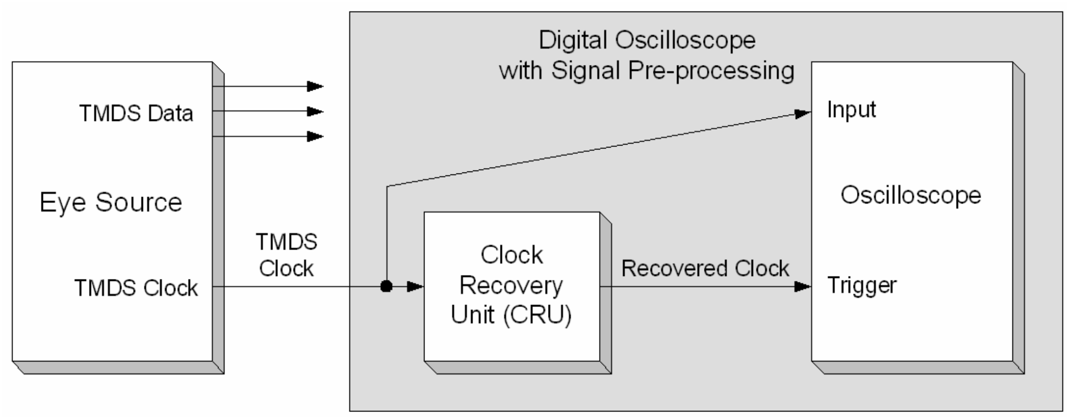


Figure 4-2 TMDS Clock Jitter Measurement

In reality, the recommended CRU consists of software that digitally processes captured data. Following the capture, the software CRU processes the captured TMDS_CLOCK waveform according to the mathematical definition of the Ideal Recovery Clock, specified in [HDMI: 4.2.3]. The eye diagram is then drawn as if a series of captures had occurred, each triggered by a Recovered Clock edge.

This type of approach can be made to work with any oscilloscope with sufficient resolution, speed, memory depth and jitter-free capture clock. Following the capture, the software CRU algorithm could process and display the resulting eye and clock edge data. A digital oscilloscope with signal pre-processing capabilities is used to provide the data capture, software processing and display.

This software approach is strongly recommended, due to the high correlation between the software implementation and the mathematical definition of the Ideal Recovery Clock.

For testing of Cable and Sinks operating at TMDS clock frequencies above 165MHz, the testing also involves use of a Reference Cable Equalizer in the Jitter/Eye Analyzer. In both Figure 4-3 and Figure 4-4, the analyzer is shown including the Reference Cable Equalizer, which is used primarily for cable output and receiver input eye measurements. Like the CRU, it is intended to approximate the ideal equalization as specified in the HDMI specification. For Source tests, the Reference Cable Equalizer is not used.

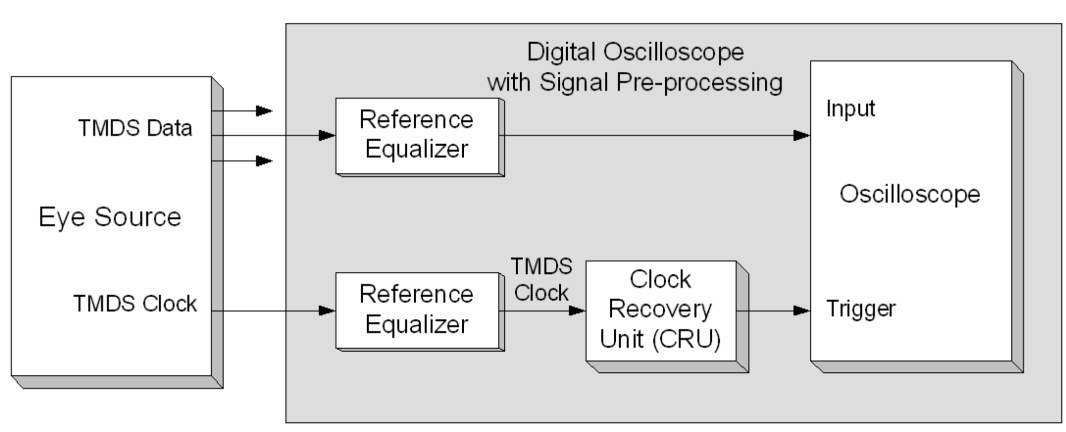


Figure 4-3 TMDS Eye Diagram Measurement With Reference Cable Equalizer

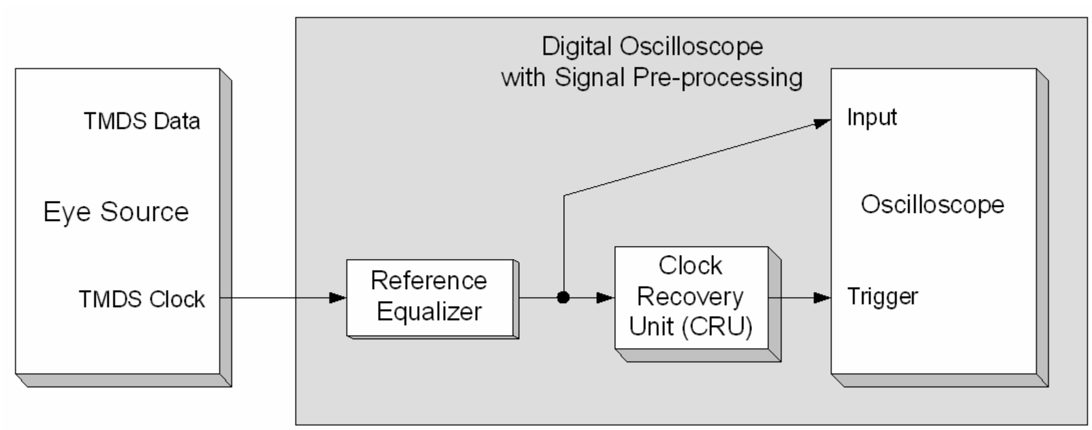


Figure 4-4 TMDS Clock Jitter Measurement With Reference Cable Equalizer

Jitter and eye measurements are used for Source, Sink, and Cable Assembly compliance testing. For Source testing, the Jitter/Eye Analyzer is used to verify the compliance of the output eye and TMDS clock jitter directly. For Sinks, the Jitter/Eye Analyzer is used during the calibration of a worst-case eye from a TMDS Signal Generator. The worst-case eye is input to the Sink to determine its data recovery capabilities. For cables, generation of a worst-case input eye and analysis of the cable's output eye are performed.

Required Test Equipment Capabilities

The Jitter/Eye Analyzer must be capable of accurately indicating the amount of jitter or the actual eye diagram on the tested TMDS differential signal.

The transfer function for an Ideal Recovery Clock is shown in Equation 4-1 below. An ideal CRU would perfectly match this function.

Across the tested clock frequency range, the Jitter/Eye Analyzer's CRU shall have a jitter transfer amplitude that differs, from the ideal transfer function, by no more than ±0.2dB from DC to 10MHz. At 20MHz the difference must be less than ±1dB and at 50MHz, less than +2/-6dB. From DC to 20MHz, the jitter transfer phase response must be within ±1.8 degrees of the phase response of the ideal recovery clock.

$$H(j\omega) = 1 / (1 + j\omega/\omega_0)$$

$$\text{Where } \omega_0 = 2\omega F_0,\ \ F_0 = 4.0\text{MHz}$$

Equation 4-1 Jitter Transfer Function of PLL for Ideal Recovery Clock Definition

The Jitter/Eye Analyzer's Reference Cable Equalizer function may be selected by the operator to be applied to all or none of the measured TMDS differential signals. The equation defining the equalizer is shown in Equation 4-2 below.

$$\left|H(j\omega)\right| = \begin{array}{ll} e^{A*\omega^N} & (\omega < \omega_0) \\ e^{-B*(\omega-1.2*\omega_0)^2+C} & (\omega_0 < \omega < 1.4*\omega_0) \\ e^{-D*\omega+E} & (1.4*\omega_0 < \omega) \end{array}$$

$$\begin{aligned} &\text{Where:} \\ &N = 0.7 \\ &\omega_0 = 2\pi * 2.25GHz \\ &A = 7.34E-8 \\ &B = \frac{7}{4} * A * \omega_0^{-1.3} \\ &C = 1.07 * A * \omega_0^{0.7} \\ &D = 0.7 * A * \omega_0^{-0.3} \\ &E = 1.98 * A * \omega_0^{0.7} \end{aligned}$$

Equation 4-2 Reference Cable Equalizer Function

<u>Configuration #1 – May be used for testing at TMDS clock rates of 148.5MHz or lower. For testing at 148.5MHz, it is better to use the alternative scopes below.</u>

- Recommended Digital Oscilloscope #1 (see section 4.2.1.3 below)
  - Tektronix TDS7404[1] 4GHz Digital Oscilloscope
- Two (2) Tektronix P7350SMA Differential Probes

<u>Configuration #2 – For testing at any TMDS clock rate</u>

- Recommended Digital Oscilloscope #2 (see section 4.2.1.3 below)
  - Agilent DSO 80000B >8GHz Digital Oscilloscope
- Agilent N5380A probe head + Agilent 1169A probe amplifier

[1] Tektronix TDS7404B is available as an equivalent successor.

Configuration #3 – For testing at any TMDS clock rate

- Recommended Digital Oscilloscope #3
  - Tektronix DPO70004 >8GHz Digital Oscilloscope (e.g. DPO70804) with option 2XL or Tektronix DSA70004 (e.g. DSA70804) (equivalent)
  - Tektronix TDSHT3 software version 3.3.0
  - Tektronix P7313SMA probe

4.2.1.3 Digital Oscilloscope

Required Test Equipment Capabilities

- ❑ For testing at TMDS clock rates of 148.5MHz or lower:
  - DC to 4GHz, -3dB bandwidth or greater
  - Input configurations:
    - 1 or more Differential Probes
    - 1 or more Single-Ended probes
  - Sampling rate >= 10G samples/sec, sampling 2 channels simultaneously.
  - Sample memory: 2 channels at >=16M samples per channel (can be acquired with a single or with multiple smaller captures)
- ❑ For testing at TMDS clock rates above 148.5MHz:
  - DC to 8GHz, -3dB bandwidth or greater
  - Input configurations:
    - 1 or more Differential Probes
    - 1 or more Single-Ended probes
  - Sampling rate >= 20G samples/sec, sampling 2 channels simultaneously.
  - Sample memory: 2 channels at >=16M samples per-channel (can be acquired with a single or with multiple smaller captures)

Recommended Test Equipment #1 – May be used for testing at TMDS clock rates of 148.5MHz or lower. For testing at 148.5MHz, it is better to use the alternative scopes below.

- Tektronix TDS7404, 4GHz Digital Oscilloscope with:
  - large memory option (#4M)
  - serial pattern trigger option (#ST)
  - Tektronix TDSHT3 software version 3.3.0
    - TDSHT3 may be used only as described in test methods below.

Recommended Test Equipment #2 – For testing at any TMDS clock rate

- Agilent DSO80000B >=8GHz Digital Oscilloscope (e.g. DSO80804B)

[2] Tektronix TDS7404B is available as an equivalent successor.

  - DSO80000-001 1-2M memory
  - Agilent HDMI compliance test software N5399A version 2.0.0

Recommended Test Equipment #3 – For testing at any TMDS clock rate

- Tektronix DPO70000 >=8 GHz Oscilloscope (e.g. DPO70804) with option 2XL or Tektronix DSA70000 >=8 GHz Oscilloscope (e.g. DSA70804) (equivalent)
  - Tektronix TDSHT3 software version 3.3.0

4.2.1.4 Differential Probe

Required Test Equipment Capabilities

- For testing at TMDS clock rates less than or equal to 74.25MHz:
  - DC - 3.5GHz bandwidth (or greater) when connected to the oscilloscope
- For testing at TMDS clock rates above 74.25MHz:
  - DC – 8GHz bandwidth (or greater) when connected to the oscilloscope
- Length of Ground Lead is less than 7cm

Recommended Test Equipment #1 – For use with Tektronix oscilloscope, but only at TMDS clock rates less than or equal to 74.25MHz

- Tektronix P7330 Differential Probe
  - Tektronix 016-1884-00 Square Pin Adapter
  - Tektronix 196-3469-00 Ground Lead

Recommended Test Equipment #2 – For use with Agilent oscilloscope

- Agilent 1169A (12GHz) probe amplifier
- Agilent N5380A probe head

Recommended Test Equipment #3 – For testing at any TMDS clock rate

- Tektronix P7313SMA

4.2.1.5 Differential SMA Probe

Required Test Equipment Capabilities

- For testing at TMDS clock rates less than or equal to 74.25MHz:
  - DC - 3.5GHz bandwidth (or greater) when connected to the oscilloscope
- For testing at TMDS clock rates above 74.25MHz:
  - DC – 8GHz bandwidth (or greater) when connected to the oscilloscope
- Differential Input Resistance : 100 Ω
- Single-ended Input Resistance : 50 Ω
- DC Bias Port for Common Mode Voltage termination
- Can connect directly and reliably to the TPA-P-SMA or TPA-R-SMA fixtures

Recommended Test Equipment #1 – For use with Tektronix oscilloscope, but only at TMDS clock rates less than or equal to 74.25MHz

- Tektronix P7350SMA Differential Probe
    - Tektronix 174-4866-00 Matched pair SMA cables

Recommended Test Equipment #2 – For use with Agilent oscilloscope at any TMDS clock rate

- Agilent 1169A (12GHz) probe amplifier
- Agilent N5380A probe head

Recommended Test Equipment #3 – For use with Tektronix oscilloscope, at any TMDS clock rate

- Tektronix P7313SMA

4.2.1.6 Single-Ended Probe

Required Test Equipment Capabilities

- DC - 4GHz bandwidth (or greater) when connected to the oscilloscope .
- Can connect directly and reliably to corresponding TPA-P or TPA-R fixtures

Recommended Test Equipment #1 – For use with Tektronix TDS7404 oscilloscope

- Tektronix P7240
    - Tektronix 016-1773-00 Square pin socket

Recommended Test Equipment #2 – For use with Agilent oscilloscope

- Agilent 1169A, configured to perform single-ended measurements.
- Agilent N5380A probe head

Recommended Test Equipment #3 – For testing at any TMDS clock rate

- Tektronix P7313SMA, configured to perform single-ended measurements.

4.2.1.7 SMA Cables

Required Test Equipment Capabilities

- ❑ Less than 2 meters, preferably less than 1 meter.
- ❑ Bandwidth: 9GHz or greater
- ❑ 50Ω impedance

Recommended Test Equipment

Any of the following are sufficient:

- Tektronix 174-1428-00 (1.5 meter)
- Tektronix 174-1341-00 (1 meter)
- Agilent N4871A matched pair cable

4.2.1.8 50Ω SMA Terminators

<u>Required Test Equipment Capabilities</u>

- ❑ 50Ω impedance ± 1% or better
- ❑ Connects directly to SMA female.

<u>Recommended Test Equipment</u>

Any lab-quality terminator which meets requirements above is sufficient.

4.2.1.9 TMDS Signal Generator

Generates HDMI signal with a variety of patterns, clock jitter, data waveform (eye diagram) and amplitude characteristics.

<u>Required Test Equipment Capabilities</u>

Capable of outputting an HDMI signal with any of the following characteristics that are supported by the DUT:

- Video format timings: 24-bit (normal) and 36-bit versions of following timings
  - 1920x1080p @ 60Hz
  - 1920x1080p @ 50Hz
  - 720x480p @ 59.94Hz
  - 1920x1080i @ 60Hz
  - 1280x720p @ 60Hz
  - 720x576p @ 50Hz
  - 1920x1080i @ 50Hz
  - 1280x720p @ 50Hz
- Data Patterns
  - Patterns Available
    1) "RGB" pattern (available for all video formats above and with 24-, 30-, 36- and 48-bit pixel sizes): RGB pixel encoding: Repeating gray scale ramp 0, 1, 2…254, 255, 0, 1, 2…during each active video period. For deep color patterns, each step in the gray ramp (0 to maximum) is 4, 16 or 256 for 30-, 36- and 48-bit color respectively.
    2) "YCbCr 4:2:2" pattern (available for 720x480p and 720x576p video formats and 24-bit pixel size only): YC_BC_R 4:2:2 pixel encoding: Repeating gray scale ramp. This should display the same as the RGB gray ramp, i.e. the displayed ramp should increment every pixel.
    3) "YCbCr 4:4:4 pattern (available for 720x480p and 720x576p video formats and 24-bit pixel size only): YC_BC_R 4:4:4 pixel encoding: Repeating gray scale ramp. This should display the same as the RGB gray ramp, i.e. the displayed ramp should increment every pixel.
  - Audio format:

        - For VGA or [480p and 576p] formats only at 24-bit/pixel RGB only: 2-channel 16-bit L-PCM audio at 48kHz sampling frequency, N and CTS values (constant) per recommended values for 48kHz at transmitted video frequency [HDMI: Table 7-3].
    - Audio data:
        - 1kHz sine wave with amplitude of –18 dBFS (full scale) on Left channel
        - 400Hz or 500Hz sine wave with amplitude of –18 dBFS (full scale) on Right channel
    - Additional Data
        - During vertical blanking, one compliant AVI and one Audio InfoFrame packet whenever required.
- +5V Power always set to +5.0V
- TMDS Clock signal characteristics:
    - Ability to add the following sinusoidal Jitter components
        - 1MHz and 7MHz. NOTE: the 1MHz component is used to emulate data jitter, while the 7MHz component is used to emulate clock jitter.
        - 500kHz and 10MHz. NOTE: the 500kHz component is used to emulate data jitter, while the 10MHz component is used to emulate clock jitter.
        - The amplitude of all jitter components can be adjusted independently from 0.0 to 1.0 Tbit (up to max of 1.1nsec) with resolution of $0.05*T_{BIT}$ or smaller
- TMDS Data signal characteristics:
    - Data Eye shape
        - Rise time, fall time can be changed to match slope of TP1 eye diagram at following test frequencies: 27MHz, 74.25MHz, 148.5MHz, 165MHz, 222.75MHz, 340MHz. This may require addition of an appropriate transition time converter (TTC).
        - Overshoot ≤10% of differential 1Vp-p swing.
        - Undershoot ≤10% of differential 1Vp-p swing.
    - Intrinsic TMDS_DATA Jitter no greater than 0.15 Tbit
- All Outputs:
    - Common Mode (average) voltage levels (when driving a 50Ω termination to 3.3V):
        - 2.9V to 3.3V (may require addition of a Bias-T on outputs)
    - Output: Differential swing range:
        - 0V (±0.06V) to 1.2Vp-p in 10mV steps
    - Channel-to-channel skew range:
        - 0 to 37 nsec (i.e. 1 $T_{CHARACTER}$@ 27MHz TMDS clock) in steps less than or equal to $0.1T_{BIT}$ of tested frequency

Recommended Test Equipment #1 – For testing at TMDS clock frequencies of 74.25MHz or lower

The recommended TMDS Signal Generator based on the Tektronix DTG consists of the following components:

- (1) Tektronix DTG5274 2.7GHz Digital Timing Generator (DTG)
  - (3) Tektronix DTGM30 output modules
- (1) Tektronix AWG710 Arbitrary Waveform Generator
  - (1) SMA (female)-BNC (male) adapter
- (2) Mini-Circuits ZFBT-4R2GW Bias-Tee
  - (2) Tektronix 012-1503-00 Pin Header SMB cable 51cm (20in.)
  - (2) Tektronix 015-0671-00 SMB-BNC adapter
  - (2) BNC (female)-SMA (male) adapters (1 for each Bias-Tee)
  - (2) SMA (female)-SMA (female) adapters (1 for each Bias-Tee)
  - (2) SMA (male)-SMA (male) adapters (1 for each Bias-Tee). Note that SMA cables (below) may be used instead of directly connecting the Bias-Tees to the AWG front panel with these adapters.
- (10 or 12) SMA Cables: either Tektronix 174-1428-00 (1.5 meters) or Tektronix 174-1341-00 (1 meter), as needed to connect output of equipment to TPA boards and to deliver synchronization signal(s) between AWG and DTG

Recommended Test Equipment #2 – For testing at any TMDS clock rate

Agilent HDMI TMDS Signal Generator configuration, consisting of the following components:

- (1) Agilent E4887A-007 TMDS Signal Generator
- (1) Agilent E4887A-307 Accessory and Cable Kit for E4887A-007 TMDS Signal Generator
- (2) Agilent E4438 series Signal Generators bandwidth >4GHz
  - Option 504 250kHz - 4GHz
  - Option 601 Internal baseband generator, 8Msa memory with digital bus
- (8) Picosecond Pulse Labs 5542 Bias-Tee
  - available as part of (1) BIT-HDMI-BTK-0001 Bias-Tee Kit for E4887A-007
- (1) Agilent E4887A-207 HDMI Frame Generator Software for E4887A-007
- (1) Agilent Test Automation Software Platform N5990A
  - Option 150 HDMI Electrical High-Speed Sink Test Library
  - Option 250 Interface to N5399A Electrical Source Tests

Note that this equipment configuration has AC-coupled output characteristics, which may differ from the DC-coupled HDMI source specifications.

Recommended Test Equipment #3 – For testing at any TMDS clock rate

- (1) Tektronix DTG5334, 3.4GHz Digital Timing Generator. (Note - DTG5334 requires S/N greater than B020100 for testing at clock rates above 222.75MHz).
  - (3) Tektronix DTGM30 output modules. (Note - DTGM30 requires S/N greater than B020100 for testing at clock rates above 222.75MHz)
  - (1) Tektronix DTGM32 clock output module
- (1) AFG or AWG jitter source, either:
  - Tektronix AFG3102 Arbitrary Function Generator (AFG), or,
  - Tektronix AWG710 or AWG7102 Arbitrary Waveform Generator (AWG)
- (10 or 12) SMA Cables: either Tektronix 174-1428-00 (1.5 meters) or Tektronix 174-1341-00 (1 meter), as needed to connect output of equipment to TPA boards and to deliver synchronization signal(s) between AWG and DTG

4.2.1.10 Network Analyzer

Required Test Equipment Capabilities

- 4 ports used simultaneously
- At least 300kHz - 4.125GHz bandwidth is available.
- Dynamic accuracy over the frequency range 300kHz - 4.125GHz
  - Magnitude: ≤ (±)0.50dB from 0 to – 50dBm
  - Phase: ≤ (±) 4 degrees from 0 to – 50dBm

Recommended Test Equipment #1

- ADVANTEST R3860A
- ADVANTEST R17051 (Auto Cal KIT)

Recommended Test Equipment #2

- Agilent E5071C : ENA Series Network Analyzer
- Agilent E5071C option 480 : 4-port Test Set, 9 kHz to 8.5 GHz
- Agilent N4431B : 4-port RF E-Cal module

4.2.1.11 TDR/TDT Oscilloscope

Required Test Equipment Capabilities

- TDR measurement
  - Bandwidth : ≥ 18GHz
  - Pulse rise time : ≤ 75ps (10-90%)
  - 2 port (1 differential in-out)
  - Ability to adjust the effective rise time of the TDR waveform that is displayed on the screen to a value below but very close to 200 ps (10-90%).

- TDT measurement
  - Bandwidth: ≥ 18GHz
  - Pulse rise time : ≤ 75ps (10-90%)
  - 4 port (1 differential out and 1 differential in)

Recommended Test Equipment #1

- (1) Tektronix TDS8200B
- (1) Tektronix 80E04 TDR-module
- (1) Tektronix 80E03 Sampling module

Recommended Test Equipment #2

- Agilent 86100C Digital Communications Analyzer
- Agilent 86100C Option 202 Enhanced TDR and S-parameter application
- Agilent 54754A TDR/TDT Module
- Agilent 86112A Dual Electrical Receiver module or second 54754A module

4.2.1.12 DC Source/Meter and Probe

Required Test Equipment Capabilities

- Basic DC voltage, DC current, DC resistance measurement capability as well as ISVM and VSIM capabilities.
- Both ISVM function and VSIM function capability
  - ISVM: Can measure the voltage with controlling the max drain current
  - VSIM: Can measure the current with controlling the output voltage.
- Indicate the value of the DC resistance as a digital number.
- DC resistance resolution is more than 3 digits.
- DC resistance accuracy is ≤ ±1%.
  - In-circuit test capability: range 0 - 100Ω must be measured.
  - At least 1MΩ (disconnected) must be measured.
- Indicates the value of the DC voltage as a digital number.
- DC voltage resolution is smaller than 10mV when range is more than 10V.
- DC voltage accuracy is ≤ ±1%

Recommended Test Equipment

- ADVANTEST R6240A DC Voltage Current Source/Monitor

4.2.1.13 Digital Multi-Meter

Required Test Equipment Capabilities

- Basic DC voltage, DC resistance measurement capability.
- DC voltage
  - DC voltage resolution ≤ 1μV when range is 0-1mV.
  - DC voltage accuracy ≤ ±10μV when range is 0-1mV.
  - Indicates the value of the DC voltage as a digital number.
- DC resistance
  - DC resistance resolution is more than 3 digits.
  - DC resistance accuracy ≤ ±1%.
  - At least 1MΩ (disconnected) must be measured.
  - Indicate the value of DC resistance as a digital number.

Recommended Test Equipment

Any digital multi-meter meeting the above requirements may be used. One such option is:

- ADVANTEST R6552

4.2.1.14 Resistor for HPD Test

Required Test Equipment Capabilities

- For Sink testing; 10kΩ ≤ ±1%, 0.25W
- For Source testing 1.2kΩ ≤ ±1%

Recommended Test Equipment

Any resistor with the Required Capabilities is sufficient.

4.2.1.15 DC Power Supply

Required Test Equipment Capabilities

- Can output DC 3.3V and 5V with accuracy of ≤ ±1%
- Maximum output current can be set with accuracy of ≤ ±5% over the 10 to 100mA range.

Recommended Test Equipment

Any DC power supply meeting the above requirements may be used. One such option is:

- KENWOOD PW18-1.8AQ

4.2.1.16 Digital LCR Meter

Required Test Equipment Capabilities

- Test signal specification
  - Frequencies: 100kHz
  - AC level: 2.5Vp-p and 3.5Vp-p
  - DC level: 1.65V and 2.5V
- Resolution is equal or less than 1pF
- Accuracy is equal or less than 1pF

Recommended Test Equipment

- HIOKI 3522-50 Digital LCR Meter
- HIOKI 9143 Probe
- HIOKI 9268-01 DC Bias unit

4.2.1.17 HDMI Cable Emulators

HDMI cable emulators are intended to emulate the characteristics of worst-case but compliant cables. All of the cable emulators can be used with all of the TMDS Signal Generators and must be made available for all of the TMDS Signal Generators.

Required Test Equipment Capabilities

- Attenuation or skew affected TP2 eye degradation or ISI jitter is compliant with cable specification.
- TMDS_DATA jitter degradation of 0.2 T_{BIT} ± 0.015 T_{BIT} measured at the crossing point.
- Output signal meet TP2 eye mask at four corners exept for most left and most right point.

Recommended Test Equipment – Tentative

There are three types of recommended HDMI cable emulators, each targeting a different type of signal degradation but compliant with cable specification on the TMDS channels.

Type 1

The Type 1 cable emulators have typical copper attenuation and inter-symbol interference (ISI) effects. When a 74.25MHz TP1 worst-case signal is applied to the input of the Category 1 emulator, it will output a worst-case TP2 signal that still meets the TP2 eye mask but with approximately 0.2Tbit of ISI. The Category 2 device has the same characteristics, but for 165MHz signals.

- Category 1: Agilent E4887A-101
- Category 2: Agilent E4887A-102

Type 2

The Type 2 cable emulators degrade the TMDS signals through large intra-pair skew, slight attenuation and very slight ISI. When a TP1 worst-case signal is applied to the input, it will generate an almost worst-case TP2 signal, with horizontal degradation primarily due to intra-pair skew. There are two versions: one for 27MHz and one for 74.25MHz testing.

- 27MHz: JAE DC1P19ST02700AA
- 75MHz: JAE DC1P19ST07425AA

Type 3

The Type 3 cable emulators are intended to emulate passive equalized cables and primarily attenuate the signal and add a very slight amount of ISI. They are used for testing at all Category 2 rates. At both 165MHz (measured without Reference Cable Equalizer) and at 340MHz (measured after application of Reference Cable Equalizer), a worst-case TP1 eye will output a TP2 eye with the 4 corner points of the eye nearly touching.

- Agilent E4887A-103 (or E4887A-104 equivalent which is divided into eight modules.)

4.2.1.18 Transition Time Converter

Transition time converters are used to control the slew rate of the TMDS Signal Generator to create a consistent slew rate among the different generators and to attain a slew rate to match a particular eye diagram.

Required Test Equipment Capabilities

- TTC is implemented in hardware (at the output of the Signal Generator) and may be optionally implemented in software (in the Digital Oscilloscope) as an equivalent method for cable testing.
- When used with a particular TMDS Signal Generator, the transition time converter will decrease the slew rate such that the slew rate near the middle of the swing will match that of the left edge of the HDMI-specified TP1 eye at a particular test frequency.
  - Software TTC is applied during the calculation of the eye diagram by applying a mathematical TTC that is equivalent to the hardware TTC requirement above.
- TTCs are used for all of the recommended TMDS Signal Generators and at the following test frequencies:
  - 74.25MHz, 165MHz, 340MHz – required for testing cables
  - 74.25MHz, 148.5MHz, 222.75MHz – required for testing Sink DUTs

Recommended Test Equipment #1 – For use with the Tektronix DTG5274

- Tektronix 250ps 015-0711-00
  - 74.25MHz 250ps+250ps+250ps

Recommended Test Equipment #2 – For use with the Agilent E4887A-007 ParBERT

- 74.25MHz: 450ps Picosecond Pulse Labs 5915-110-450PS
- 148.5MHz: 220ps Picosecond Pulse Labs 5915-110-220PS
- 165MHz: 200ps Picosecond Pulse Labs 5915-110-200PS
- 222.75MHz: 150ps Picosecond Pulse Labs 5915-110-150PS
- 340MHz: 60ps PIcosecond Pulse Labs 5915-110-60PS

Recommended Test Equipment #3 – For use with the Tektronix DTG5334

- Tektronix 150ps 015-0710-00
- Tektronix 250ps 015-0711-00
- These devices can be configured for configuring the eye to meet the following:
  - 74.25MHz 250ps+250ps+250ps
  - 148.5MHz 250ps
  - 165MHz 150ps+150ps
  - 222.75MHz 150ps
  - 340MHz 0ps

4.2.2 Connector Testing

There are a number of tests designed to verify compliance of the connector with HDMI-specified dimensions or performance. The HDMI Compliance Test Specification does not attempt to describe the test equipment or processes required for this testing.

4.2.3 EDID/DDC/CEC Testing

4.2.3.1 EDID Reader/Analyzer

The Sink's EDID is read and evaluated by the EDID Reader/Analyzer.

Required Test Equipment Capabilities

The EDID Reader/Analyzer shall be capable of:

- reading all bytes of all blocks within the EDID,
- presenting the entire contents of the EDID to the operator in an easily understandable format
- detecting and clearly indicating to the operator the failure to comply with at least some of requirements referenced in Section 8.2.
- allowing the operator to manually but easily identify compliance with the remaining items in Section 8.2.

Recommended Test Equipment

- Quantum Data 882CA Generator/Analyzer (Rev. C with Analyzer option)
- PC running Quantum Data software on Windows OS

4.2.3.2 EDID Emulator

An EDID image may be presented to a Source DUT by connecting an EDID Emulator to the SDA and SCL signals on any of the standard TPA fixtures.

Required Test Equipment Capabilities

The EDID Emulator shall be capable of:

- presenting a 2-block (256-byte) and a 4-block (512-byte) E-EDID to a Source,
- applying 3.3V through a 50 ohm resistance to each of the eight TMDS lines,
- connecting to the +5V Power, SDA and SCL signals of any standard TPA fixture,

Recommended Test Equipment #1

The recommended EDID Emulator includes:

- Quantum Data 882CA Generator/Analyzer (Rev. C with Analyzer option).
- PC running Quantum Data software on Windows OS

Recommended Test Equipment #2

The recommended EDID Emulator includes:

- Silicon Image CP9100 EDID Tester Kit.
- PC running Windows 32-bit OS.

The Silicon Image CP9100 consists of the following:

- Silicon Image EDID Tester PCB. This hardware provides a variety of EDID-related functions. In this use, it can be attached to a Source DUT in order to provide a complete Sink emulation function at the TPA.
- Serial cable. Connected between the PC and the EDID Tester PCB, allowing the PC to acquire the EDID image read from the Sink.
- Silicon Image EDID Analyzer / Editor Software. This software is designed to enable the operator to create and edit EDID images per the HDMI Specification, VESA E-EDID 1.3, and CEA-861-D and to download those images into the EDID Tester PCB.

To use this equipment as an EDID Emulator do the following:

- Connect the PC to the EDID Tester PCB using the serial cable.
- Connect the EDID Tester PCB to the TPA fixture's SDA, SCL, +5V Power and Ground signals.
- Run the EDID Analyzer/Editor software and download the appropriate image.
- Press the HPD button for ½ second or so to notify the Source DUT of the new EDID image.

Recommended Test Equipment #3 – for use with EFF-HDMI-TPA-x fixtures

- EFF-HDMI-E-EDID-TPA.

4.2.3.3 I^{2}C Analyzer

An I^{2}C analyzer is required to test E-DDC.

Required Test Equipment Capabilities

The I^2C analyzer shall be capable of:

- Displaying all elements of an I^2C transaction in a manner that allows the operator to determine if the transaction is compliant with the E-DDC protocol.
- Ability to be connected to the SDA and SCL signals on an EDID Emulator PCB or TPA fixture.
- Ability to measure the worst-case SCL frequency (minimum period between rising edges of SCL)

Recommended Test Equipment

Any I^2C analyzer meeting the above requirements may be used. One such option is:

- Yokogawa DL1640/F5 Oscilloscope (includes I^2C Analyzer option)

4.2.3.4 General Oscilloscope

Required Test Equipment Capabilities

- Specific capability is not required for General Oscilloscope

Recommended Test Equipment

- Any type of oscilloscope may be used.

4.2.4 Protocol Testing

4.2.4.1 Encoding Analyzer

The Encoding Analyzer is used to verify correct low-level encoding by the Source DUT.

Required Test Equipment Capabilities

The Encoding Analyzer is capable of analyzing an HDMI signal and detecting the following:

- Any illegal 10-bit code generated by a Source on any of the three channels. Legal codes are limited to the following:
  - Any legal Video Data codes
  - 4 Control Period codes
  - 16 TERC4 codes
  - 4 Data Island Guard Band codes
  - Video Guard Band code
- Any Video Data Code that was encoded with an incorrect “data stream disparity” value, that is, which causes the channel to become more, rather than less DC-balanced.
- Any $T_{CHARACTER}$ period that does not use a consistent coding method across all three TMDS channels.

The Encoding Analyzer should be capable of recovering the data from any compliant HDMI signal with a bit error rate of better than 10^{-9}. The Encoding Analyzer shall be designed assuming no data recovery errors. On occasion, a test may therefore fail due to a rare, but permitted, data recovery error. The operator may re-run the test in the case of these intermittent errors.

The Encoding Analyzer shall be capable of attaining character synchronization (detection of the start of the 10-bit code on each channel) following the reception of 12 contiguous Control Period-encoded pixels and of maintaining the synchronization for the duration of the data capture.

Recommended Test Equipment #1

- Panasonic UITA-1000-based setup, described below

Recommended Test Equipment #2

- Agilent N5998A -based setup, described below

Panasonic UITA-1000 HDMI Protocol Analyzer

This tool can act as a recommended Encoding Analyzer, Protocol Analyzer, Audio Timing Analyzer and Video Timing Analyzer. UITA-1000 supports only Primary video formats and 24-bit pixel format.

This tool consists of the following components:

- Panasonic UITA-1000 Data Acquisition Unit
- Personal Computer running a Windows 32-bit OS with an IEEE1394 port available and connected to the TMDS Capture Board for downloading the captured TMDS sequences.
- Panasonic UITA-1000 HDMI Analysis Software running on the PC
- IEEE1394 cable connected between Data Acquisition Unit and PC

The HDMI Analysis software has the following major features:

- Can download the data file from the TMDS Capture Hardware
- Can execute several commands selected via menus that perform different groups of tests.
- Can output the results of the tests on-screen and/or to a text file, indicating, for each test performed, a PASS or FAIL result.
- Can output a processed HDMI protocol sequence data file, outlining the positions of Data Islands, specific packet types, Video Data Periods, Preambles, etc. and including markers indicating at the positions in the sequence where specific tests failed.

The Recommended Test Methods using the Panasonic UITA-1000 will describe which HDMI Analysis commands are executed and what the indication will be if that test fails or passes. Following are the configuration and operation instructions for the Panasonic UITA-1000.

- Connect Source DUT to the TMDS Capture board with an HDMI cable.
- Connect the TMDS capture board to the PC with an IEEE1394 cable.
- If required, connect a Timer/Counter to the appropriate test points and set to Frequency mode.
- Operate the Source DUT as described in the Recommended Test Method.

- Initiate the “Capture” operation of the TMDS Capture board. Continue the operation of the Source DUT for the duration of the capture.
- Run the HDMI Analysis software on the PC.
- Select the HDMI Analysis “Download Capture” command. If needed, input the TMDS clock frequency value read from the Timer/Counter. Save the capture file.
- Select the command specified in the Recommended Test Method and select the capture file just saved.
- Examine the output of the HDMI Analysis software for the indication described in the Recommended Test Method and document the results in the Test Results Form as instructed.

Agilent N5998A Protocol/Audio/Video Analyzer

This tool can act as a recommended Protocol Analyzer, Audio Timing Analyzer and Video Timing Analyzer.

This tool consists of the following components:

- Agilent N5998A Unit
- Personal Computer running a Windows 32-bit OS with a USB 2.0 port available and connected to the Agilent N5998A unit for downloading the captured TMDS sequences.
- Agilent N5998A HDMI Analysis Software running on the PC
- USB 2.0 cable connected between N5998A Unit and PC

The HDMI Analysis software has the following major features:

- Can download the data file from the N5998A Unit
- Can execute several commands selected via menus that perform different groups of tests.
- Can output the results of the tests on-screen and/or to a text file, indicating, for each test performed, a PASS or FAIL result.
- Can output a processed HDMI protocol sequence data file, outlining the positions of Data Islands, specific packet types, Video Data Periods, Preambles, etc. and including markers indicating the positions in the sequence where specific tests failed.

The Recommended Test Methods using this tool will describe which HDMI Analysis commands are executed and what the indication will be if that test fails or passes. Following are the configuration and operation instructions for the N5998A Unit.

- Connect Source DUT to the N5998A Unit with an HDMI cable.
- Connect the N5998A Unit to the PC with a USB 2.0 cable.
- If required, connect a Timer/Counter to the appropriate test points and set to Frequency mode.
- Operate the Source DUT as described in the Recommended Test Method.
- Initiate the “Capture” operation of the N5998A Unit. Continue the operation of the Source DUT for the duration of the capture.

- Run the HDMI Analysis software on the PC.
- Select the HDMI Analysis “Download Capture” command. If needed, input the TMDS clock frequency value read from the Timer/Counter. Save the capture file.
- Select the command specified in the Recommended Test Method and select the capture file just saved.
- Examine the output of the HDMI Analysis software for the indication described in the Recommended Test Method and document the results in the Test Results Form as instructed.

4.2.4.2 Protocol Analyzer

The Protocol Analyzer is used to detect protocol errors generated by a Source. Proper operation of the Protocol Analyzer is only guaranteed if the Source DUT passes all tests in Section 7.2, 7.3 and Test ID 7-16: Legal Codes.

<u>Required Test Equipment Capabilities</u>

The Protocol Analyzer data recovery and character synchronization performance requirements are identical to those of the Encoding Analyzer.

On occasion, a test may therefore fail due to a rare, but permitted, data recovery error. The operator may re-run the test in the case of these intermittent errors.

The Protocol Analyzer shall be capable of determining whether each Protocol element is compliant with the requirements described in the Source Protocol tests section. These include, but are not limited to:

- Preamble values.
- Relative placement or length of Preambles, Guard Bands, Data Islands, Control Periods, etc.
- BCH parity bits for any of the five ECC blocks in every packet.

<u>Recommended Test Equipment #1 – Can be used only for 74.25MHz operation and below.</u>

- Panasonic UITA-1000-based setup, described above

<u>Recommended Test Equipment #2 – Can be used for all TMDS clock frequencies.</u>

- Agilent N5998A -based setup, described above

4.2.5 Audio/Video Testing

4.2.5.1 Video Timing Analyzer

The Video Timing Analyzer analyzes the relative timing of pixels, HSYNC, VSYNC and Video Data Periods, and absolute pixel clock frequency, and uses this information to determine compliance with the relevant specifications. Proper operation of the Video Timing Analyzer is only guaranteed if the Source DUT passes all tests in the Source Protocol section. Note that the pixel clock rate is determined using the TMDS clock rate in conjunction with the current pixel size (24-bit, 30-bit, 36-bit, 48-bit).

Required Test Equipment Capabilities

The Video Timing Analyzer examines the transmitted video timing and shall be capable of:

- determining the exact number of pixel clocks within the horizontal front porch, HSYNC pulse, back porch and Video Data Period (excluding the Video Guard Band).
- determining the HSYNC polarity (positive or negative),
- determining the exact number of video lines within the vertical front porch, VSYNC pulse, back porch and active data period,
- determining the VSYNC polarity (positive or negative),
- determining the exact offset (in pixel clocks) of the active edge of VSYNC from to the active edge of HSYNC,
- determining the pixel clock frequency with an accuracy of ±0.01%
- determining, or allowing the operator to determine, if all of the above values match the required values specified in CEA-861-D.

Recommended Test Equipment #1 – Can be used only for 74.25MHz operation and below.

- Panasonic UITA-1000-based setup, described in section 4.2.4.1 above

Recommended Test Equipment #2 – Can be used for major TMDS clock frequencies.

- Agilent N5998A -based setup, described in section 4.2.4.2 above

4.2.5.2 Video Picture Analyzer

Required Test Equipment Capabilities

The Video Picture Analyzer allows the operator to view or otherwise examine the contents of the transmitted video and shall be capable of:

- presenting to the Source DUT, a specific EDID image selected by the operator,
- accurately indicating the contents of any and all AVI InfoFrames transmitted by the Source DUT, and
- accurately indicating, through operator observation, the aspect ratio of the transmitted picture, assuming that the picture content provides sufficient clues (circles or other obvious structures).

Recommended Test Equipment #1 – Can be used only for 74.25MHz operation and below.

The first recommended Video Picture Analyzer consists of the following components:

- Panasonic UITA-1000-based setup, described in section 4.2.4.1 above

Recommended Test Equipment #2 – Can be used for all TMDS clock frequencies.

A second recommended Video Picture Analyzer consists of the following components:

- Agilent N5998A -based setup, described in section 4.2.4.2 above

4.2.5.3 Audio Timing Analyzer

The Audio Timing Analyzer analyzes the timing and content of audio-related packets and of using this information to determine compliance with the relevant specifications. Proper operation of the Audio Timing Analyzer is only guaranteed if the Source DUT passes all tests in the Source Protocol section.

Required Test Equipment Capabilities

The Audio Timing Analyzer shall be capable of any of the following that are supported by the DUT:

- Extracting the ACR, Audio Sample Packets, High Bitrate Audio Packets and accurately timing the number of TMDS clocks since the arrival of the previous such packet.
- Extracting the Audio InfoFrame Packets and timing their arrival to determine which video field the packet was transmitted in.
- Extracting the audio sample size, sample rate, and sample rate accuracy encoded within the Channel/Status bits of the Audio Sample Packets and High Bitrate Audio Packets.
- Extracting the N and CTS values from the ACR Packets.
- Determining the TMDS clock frequency with an accuracy of ±1ppm.
- Using the above information to determine whether these values and timings are within the requirements of the HDMI and IEC 60958 specifications.

Recommended Test Equipment #1 – Can be used for 74.25MHz operation and below, and for DUTs without support for High Bitrate Audio.

- Panasonic UITA-1000-based setup, described in section 4.2.4.1 above

Recommended Test Equipment #2 – Can be used for all major TMDS clock frequencies.

- Agilent N5998A -based setup, described in section 4.2.4.2 above

4.2.5.4 Audio/Video Protocol Generator

Sink DUTs are tested using an Audio/Video Protocol Generator.

Required Test Equipment Capabilities

❑ The Audio/Video Protocol Generator shall be capable of operating in two modes:

- outputting a DVI signal carrying:
  - a valid video signal using RGB pixel encoding, or,
- outputting an HDMI signal carrying:
  - a valid video signal using RGB pixel encoding and,

  - a valid IEC60958 audio signal
  - a valid Audio InfoFrame

- …where the video signal may be configured to be any CEA Video Format Timing that is supported by the Sink DUT:…and where the audio signal consists of a 1kHz sine wave or other readily identifiable test signal and may be configured to use any of the following formats supported by the Sink DUT:
  - PCM at 32, 44.1, 48, 88.2, 96, 176.4 and 192kHz
  - And optionally, Dolby Digital (AC-3) at 44.1 and 48kHz

Also capable of generating the following special patterns:

- Valid 640x480p video frame with every horizontal and vertical blanking interval completely filled with one or more Data Islands and with all Control Periods either 12 or 13 characters in length. Note: 640x480p has 160 pixels in HBLANK (158 clocks after removing the Video Guard Band). A four packet Data Island can be centered within this period. There are multiple arrangements possible for VBLANK period.
- 720x480p and 720x576p with 2 channel 48kHz audio HDMI signal with following characteristics:
  - During VBLANK, one or more Data Islands contain a valid
    - Null Packet (0x00)
    - General Control Packet (0x03)
    - Vendor-specific InfoFrame Packet (0x81)
    - AVI InfoFrame Packet (0x82)
    - Source Product Description Packet (0x83)
    - Audio InfoFrame Packet (0x84)
    - MPEG Source InfoFrame Packet (0x85).
  - The Vendor-specific InfoFrame Packet will contain a length of 3 and a 24-bit IEEE registration identifier belonging to the HDMI Licensing, LLC (0x000C03).
  - The General Control Packet will have Set_AVMUTE and Clear_AVMUTE clear (0).
- 720x480p and 720x576p with 2 channel 48kHz audio HDMI signal with following characteristics:
  - During VBLANK, one or more Data Islands contain a valid
    - ACP Packet (0x04)
    - ISRC1 Packet (0x05)
    - ISRC2 Packet (0x06)

<u>Recommended Test Equipment #1 – For testing at all major TMDS clock frequencies, all major CEA video formats and with all color depths..</u>

The recommended Audio/Video Protocol Generator consists of the following components:

- Tektronix DTG5274/DTG5334 Digital Pattern/Timing Generator-based setup, described in section 4.2.1.9 (TMDS Signal Generator) above

Recommended Test Equipment #2 – Can be used only for the HDMI Primary Video Formats at a color depth of 24 bits/pixel.

The recommended Audio/Video Protocol Generator consists of the following components:

- Agilent E4887A-007-based setup, described in section 4.2.1.9 (TMDS Signal Generator) above

Recommended Test Equipment #3 – For testing at all major TMDS clock frequencies, all major CEA video formats and with all color depths.

- Agilent N5998A -based setup, described in section 4.2.4.2 (Protocol Analyzer) above

5 Tests – Cable Assembly

Adopters shall submit to the ATC any new Cable Assembly product that has a length that exceeds previously submitted cable products in each cable category or that has construction substantially different than that of previously submitted cable products.

Due to the difficulty of accessing the plug contacts directly, cable assembly tests may be performed using standard HDMI receptacles, at test points CTP1 and CTP2 shown in Figure 5-1 (corresponding to TP3 and TP4 as used in the HDMI Specification).

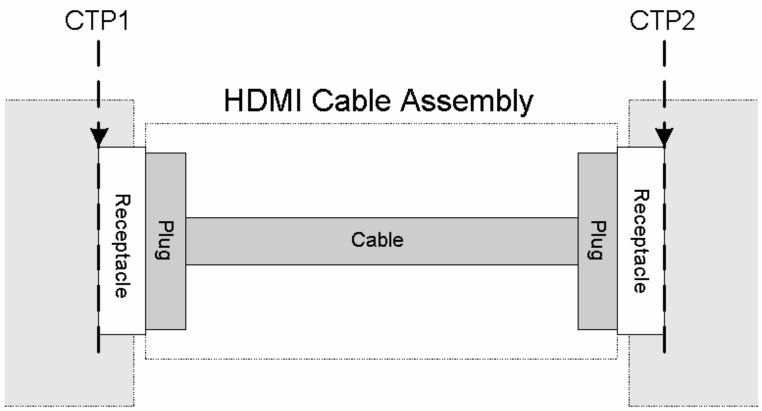


Figure 5-1 Cable Test Points

5.1 Cable – Mechanical

Test ID 5-1: Connector Maximum Envelope

Reference	Requirement
[HDMI: 4.1.9] Connector Drawings	<See reference for details.>

Test Objective

Verify that DUT's connector shell and cable fit inside minimum allowable receptacle envelope.

Required Test Method

1) Measure all overmold dimensions.

   [Verify that all dimensions fall within maximum permitted values]:
2) if overmold is closer than 9mm to the tip of the shell then FAIL
3) For the following, measure the maximum extension from the shell in the rigid portion of the connector, not in the area where the cable can flex.
4) If connector is Type A:
   4.1) If overmold extends more than 3.5mm above or below connector shell then FAIL
   4.2) if overmold extends more than 3.5mm to the left or right of the shell then FAIL
5) If connector is Type B:
   5.1) If overmold extends more than 4.5mm above or below connector shell then FAIL
   5.2) if overmold extends more than 4.5mm to the left or right of the shell then FAIL
6) If connector is Type C:
   6.1) if overmold is wider than 14mm then FAIL
   6.2) if overmold is taller than 8.4mm then FAIL

Recommended Test Method

Perform steps in Required Test Method above using a ruler, caliper, micrometer or similar.

5.2 Cable – Electrical: Performance Tests

Test ID 5-2: Wire Assignment

Reference	Requirement
[HDMI: Table 4-9] Type A-to-Type A Cable Wire Assignment	Wire assignment of Type A / Type A cable assembly
[HDMI: Table 4-10] Type A-to-Type B Cable Wire Assignment	Wire assignment of Type A / Type B cable assembly
[HDMI: Table 4-11] Type B-to-Type B Cable Wire Assignment	Wire assignment of Type B / Type B cable assembly
[HDMI: Table 4-12] Type C-to-Type A Cable Wire Assignment	Wire assignment of Type C / Type A cable assembly

Test Objective

Verify that all specified connections are present in cable and that no connections are present where not specified.

Required Test Method

If CDF field Cable_Type is not "Wire" then this test may be skipped.

Refer to one connector as "Connector 1" and the other as "Connector 2".

Using the appropriate reference for the type of cable tested (Type A/Type C vs. Type B connectors) perform the following:

- For each pin "X" from 1 to 19 (if Type A/C) or 29 (if Type B) on connector 1:
  - For each pin "Y" from 1 to 19 (if Type A/C) or 29 (if Type B) on connector 2:
    - check connection between Connector 1 pin X and Connector 2 pin Y
    - if connection is specified between Connector 1 pin X and Connector 2 pin Y and no valid connection, then FAIL
    - if no connection is specified between Connector 1 pin X and Connector 2 pin Y and not a valid no-connect, then FAIL
- If cable has Type A connector on one end and Type B on other end:
  - For each pin "X" from 13 to 21, 23 and 24 on Type B connector:
    - For each pin "Y" from X+1 to pin 24 on Type B connector:
      - check connection between pin X and pin Y
      - if connection exists between pin X and pin Y then FAIL

Recommended Test Method

If CDF field Cable_Type is not "Wire" then this test may be skipped.

For simple cables (bi-directional, wire), a valid connection is defined as <100Ω. For all signal types, a valid no-connect is defined as >1MΩ. Perform the "Required Test Method" using a standard Digital Multi-meter set for measurement of Resistance using the valid connection criteria above.

Test ID 5-3: TMDS Data Eye Diagram

Reference	Requirement
[HDMI: 4.2.6] Cable Assembly	❑ Category 1 (up to 74.25MHz): The cable shall meet either: A) the parameters specified for Category 1 cables in Table 4-21, or, B) the non-equalized eye diagram requirements at 74.25MHz. ❑ Category 2 (up to 340MHz): The cable shall meet either A) the parameters specified for Category 2 cables in Table 4-21, or, B) all of: - the non-equalized eye diagram requirements at 165MHz and, - the equalized eye diagram requirements at 340MHz
[HDMI: 4.2.7] +5V Power Signal	"A Cable Assembly shall be able to supply a minimum of 50mA to the +5V Power pin to a Sink, even when connected to a Source supplying no more than 55mA."

Test Objective

Confirm that the Cable Assembly outputs a compliant data eye.

Required Test Method

All cables must be capable of passing this test. The ATC will perform this test on all cable DUTs. However, for self-testing, this test may be skipped if all of the tests in Section 5.3, Cable – Electrical: Parametric Tests, have passed.

Setup:

1) If CDF field Cable_Category is neither 1 nor 2 then FAIL.
2) Connect the TMDS Signal Generator to the input TPA-R.
3) If the CDF field Cable_Type is "Active" (and optionally for all cables) then:
    4) Connect a +5V power supply between the +5V_Power and DDC/CEC ground signals on the input TPA and connect a 1.2kohm resistor between the +5V_Power and HPD signals on the output side.
5) If CDF field Cable_Category == 1, "test frequency" for the following is 74.25MHz.
6) If CDF field Cable_Category == 2, "test frequency" for the following is 165MHz.

7) If *software TTC equivalent method* is not being used, then, on the path between the TMDS Signal Generator and the DUT, connect a transition-time-converter (TTC) on the + and – signals of each tested TMDS_DATA pair.The value of the TTC must be sufficient to cause the signal slew rate of the cable input signal to match the slew rate of the leading edges of the HDMI-specified TP1 eye diagram at the test frequency. Add TTCs to the TMDS_CLOCK outputs, as needed, to create a TMDS rise/fall time between 75pS and 110pS.

8) Set voltage swing to 400mV and output common mode to 3.1V for every TMDS single-ended signal.

Calibrate Input Eye: (Calibration must occur as often as necessary to ensure a worst-case TP1 eye is used for each test.)

9) Using a TMDS Signal Generator, transmit a video format corresponding to the test frequency to the Cable DUT. For 340MHz test frequency, a 335MHz format may be used.

10) Connect the Digital Oscilloscope to the input TPA using a separate TPA-P. Supply 3.3V termination power to the probe or TPA-P if needed.

11) Inject 500kHz jitter onto the TMDS_CLOCK signal, starting with a jitter amplitude of $0.3{*}T_{BIT}$ (worst data jitter permitted at TP1, e.g. 0.4nS for a 74.25MHz clock).

12) Using Digital Oscilloscope, measure eye diagram of all three TMDS_DATA pairs at the input to the Cable DUT (without application of reference cable equalizer). (If *software TTC equivalent method* is being used instead of step 7 then enable the software TTC in the oscilloscope.)

13) Adjust the jitter amplitude of the TMDS_CLOCK jitter to create the input worst-case data eye diagram. This will be attained when the measured data eye nearly touches both the left-most and right-most points of the TP1 eye mask but without causing a TP1 eye mask violation. (Verify that appropriate TTC is chosen to generate appropriate TP1 mask.) Record this calibrated jitter magnitude for subsequent tests.

14) Disconnect Digital Oscilloscope and the TPA-P from the input TPA-R.

Measure Output Eye:

15) Connect Cable DUT between input and output TPA-R adapters with the Digital Oscilloscope connected to the output TPA-R. If the cable is unidirectional (CDF field Cable_Unidirectional = “Y”) then connect in the specified direction.

16) Supply 3.3V termination power to the probe or TPA if needed.

17) Measure the cable’s output eye diagrams for all TMDS_DATA channels using the CRU. If *software TTC equivalent method* is being used then enable the software TTC in the oscilloscope. If the test frequency is 340MHz, also apply the Reference Cable Equalizer before measurement.

   - For jitter measurements (informative), use a measurement box vertical setting of: 0V±5mV

18) If any measured eyes do not meet the Sink minimum eye mask then FAIL

19) If the current on +5V Power ever exceeds 5 mA then FAIL

20) If CDF field Cable_Category == 2 then repeat the above steps starting at “Calibrate Input Eye:” at a test frequency of 340MHz but enable the Reference Cable Equalizer before measuring the cable output eye diagram.

21) If the CDF field Cable_Type is not “Active” then

22) Swap the TMDS_DATA0 and TMDS_CLOCK pairs at the input to the cable DUT (from the TMDS Signal Generator) and also swap the pairs at the oscilloscope, either manually or by changing scope settings.

23) Measure the TMDS_DATA0 data eye diagram now present on the DUT's TMDS_CLOCK channel following the steps in "Measure Output Eye" above.

- Failure of this TMDS_CLOCK eye measurement does not constitute a failure of the overall compliance check. However, the adopter is strongly advised to correct the issue before shipping the product.

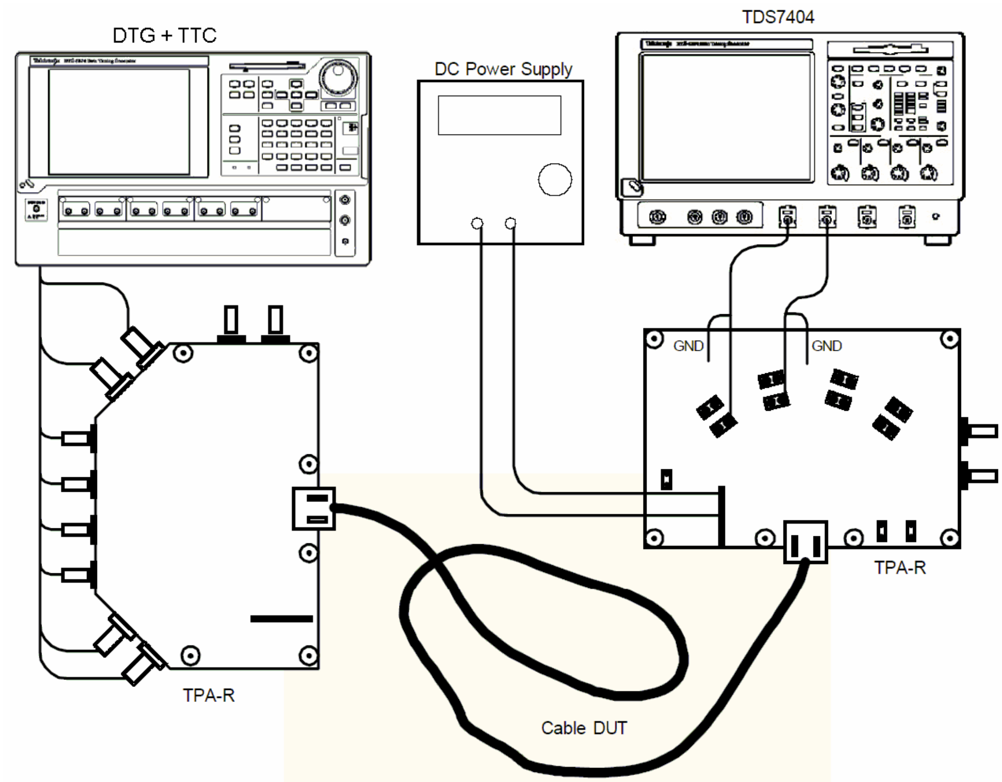
***Software TTC Equivalent Test Method*:**

If CDF field Cable_Type is "Wire" then Software TTC may be used as an Equivalent Test Method.

In this case, do not connect hardware TTC to output of TMDS Signal Generator but instead configure the oscilloscope to apply a software transition-time filter that causes the eye to match the slew rate of the HDMI-specified TP1 eye diagram at the test frequency.

Recommended Test Method – Tektronix

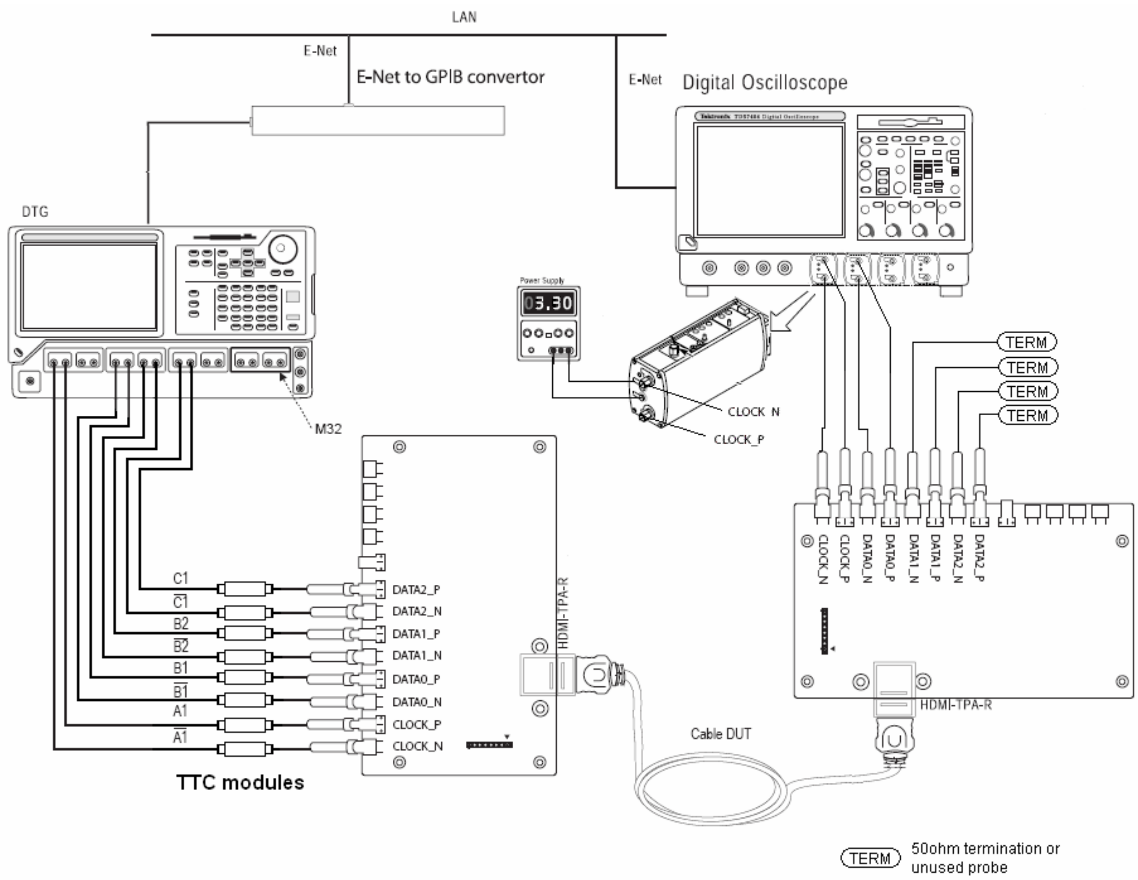
For Category 1 Testing Only:



Setup 1. Test ID 5-3: TMDS Data Eye Diagram: Tektronix TDS7404-based Setup

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Differential SMA Probes	Tektronix P7350SMA		2
3	TMDS Signal Generator	Tektronix DTG5274 or DTG5334	4.2.1.9	1
4	DC Power Supply 3.3V	<See reference>	4.2.1.15	2
5	SMA Cables	<See reference>	4.2.1.7	8
6	TPA-R (for cable output)	Tektronix TPA-R-TDR or EFF-HDMI-TPA-R	4.2.1.1.7	1
7	TPA-R (for cable input)	Tektronix TPA-R-TDR or EFF-HDMI-TPA-R	4.2.1.1.7	1
8	TPA-P (for eye calibration)	Tektronix TPA-P-TDR or EFF-HDMI-TPA-P	4.2.1.1.7	1
9	Transition Time Converters (TTC)	<See reference>	4.2.1.18	2+ (if needed)

For Category 1 or Category 2 Testing:



Setup 2. Test ID 5-3: TMDS Data Eye Diagram: Tektronix DTG5334-based Setup

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL or DSA70804 scope	4.2.1.3	1
2	Differential SMA Probes	Tektronix P7313SMA		2
3	TMDS Signal Generator	Tektronix DTG5334, including three (3) DTGM30 modules	4.2.1.9	1
4	DC Power Supply 3.3V	<See reference>	4.2.1.15	2
5	SMA Cables	<See reference>	4.2.1.7	8
6	TPA-R (for cable output)	EFF-HDMI-TPA-R/ EFF-HDMI-TPA-R-CAL	4.2.1.1.3	1
7	TPA-R (for cable input)	EFF-HDMI-TPA-R-CAL	4.2.1.1.7	1
8	TPA-P (for eye calibration)	EFF-HDMI-TPA-P	4.2.1.1.7	1
9	Transition Time Converters (TTC)	<See reference>	4.2.1.18	2+ (if needed)

1) If CDF field Cable_Type is “Wire” then

2) Optionally configure the oscilloscope to apply a software transition-time filter that causes the eye to match the slew rate of the HDMI-specified TP1 eye diagram at the test frequency. The degree of filtering will depend upon the rise time of the DTG.

3) If CDF field Cable_Type is not “Wire” or if no software TTC is being used then

4) Add a transition-time-converter module (TTC) onto each of the six TMDS_DATA signals with a value that causes the signal slew rate to match the slew rate of the leading edges of the HDMI-specified TP1 eye diagram.

5) Connect DTG to “input” TPA-R using eight 1 meter (preferable) or 1.5 meter SMA cables or use recommended cable supplied with TPA-R-TDR fixture:

- Module A, Channel 1+, 1–: connect to TMDS_CLOCK+, –
- Module A, Channel 2+, 2–: No connect
- Module B, Channel 1+, 1–: connect to TMDS_DATA0+, – (“DATA0_P”, “DATA0_N”)
- Module B, Channel 2+, 2–: connect to TMDS_DATA1+, –
- Module C, Channel 1+, 1–: connect to TMDS_DATA2+, –
- Module C, Channel 2+, 2–: No connect

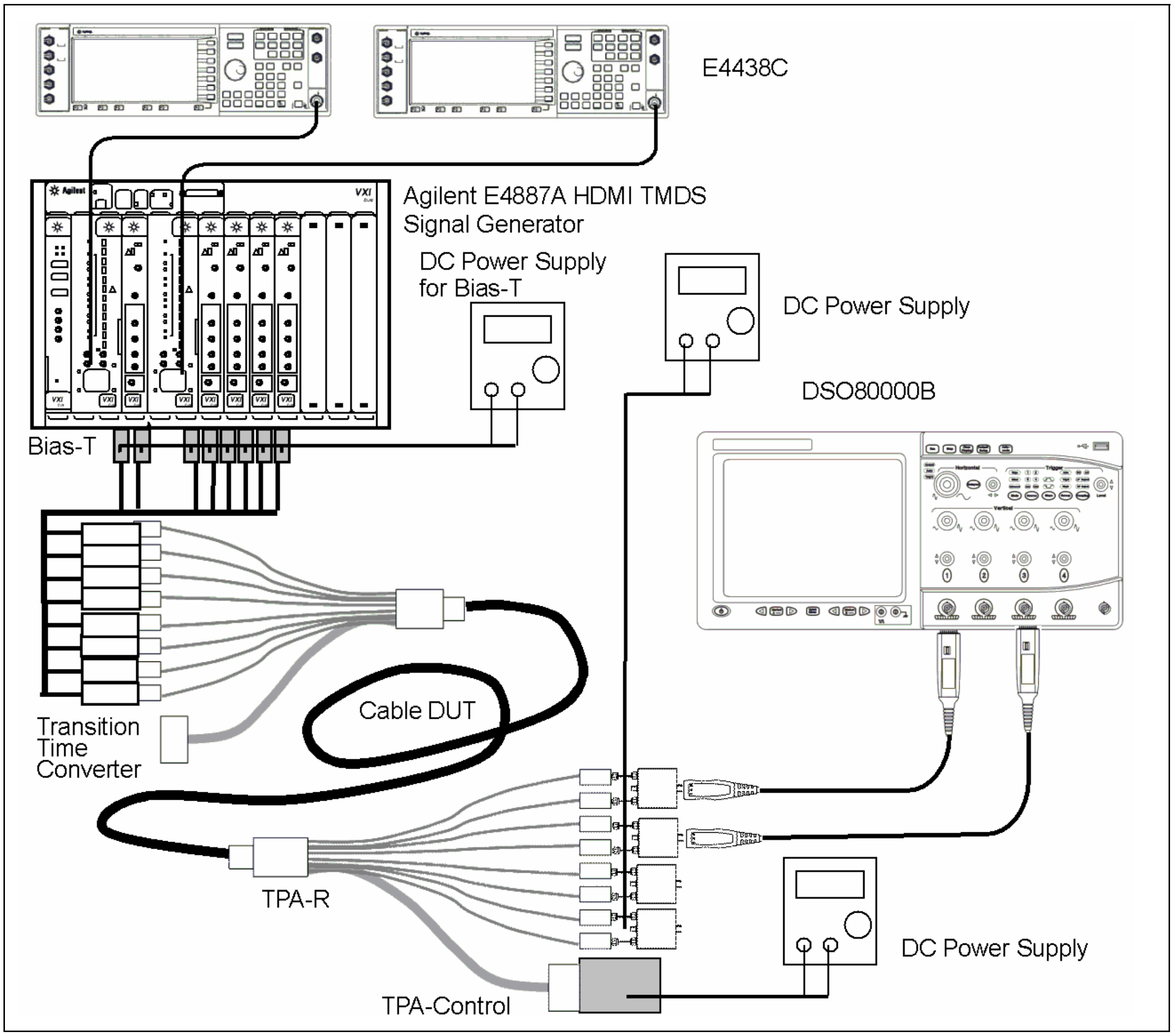
6) Connect Oscilloscope to “input” TPA-R by using a TPA-P with two Differential Probes. Supply 3.3V power to the probes.

Perform the steps in the Required Test Method. Tektronix TDSHT3 software may be used to automate the test sequence.

Note that this configuration allows the addition of jitter to the TMDS_CLOCK pair using the DTG. Alternatively, an AWG, configured as shown in Test ID 8-7, could be used to generate the TMDS_CLOCK signal with jitter.

Note: The setup drawings above show the testing configuration for the output measurement steps. For the eye calibration steps, use a TPA-P on the oscilloscope, connected directly to the “input” TPA-R from the TMDS Signal Generator.

Recommended Test Method – Agilent



Setup 3. Test ID 5-3: TMDS Data Eye Diagram: Agilent ParBERT-based Setup

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	2
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	4
4	TMDS Signal Generator	Agilent E4887A	4.2.1.9	1
5	Bias-T	<See reference>	4.2.1.9	8
6	DC Power Supply	<See reference>	4.2.1.15	3
7	SMA Cable	Agilent N4871A	4.2.1.7	8
8	Transition Time Converters (TTC)	<See reference>	4.2.1.18	2 +
9	TPA-P (for eye calibration)	Agilent N1080A Option 101	4.2.1.1.2	1
10	TPA-R (for cable input and output)	Agilent N1080A Option 102	4.2.1.1.3	2
11	Agilent TPA-Control	Agilent N1080A Option 103	4.2.1.1.4	1

1) If CDF field Cable_Type is “Wire” then

    2) Optionally configure the oscilloscope to apply a software transition-time filter that causes the eye to match the slew rate of the HDMI-specified TP1 eye diagram at the test frequency.

    - In "Select Test" tab of N5399A HDMI compliance test software,
        - select Cable/Receiver test
        - select Eye diagram
    - In "Configure" tab of N5399A
        - select "manual select" in the Equalizer/Filter mode
    - Then measurement start
    - After the equalizer/filter selection window appears, select proper software TTC file for the measured clock rate.

3) If CDF field Cable_Type is not “Wire” or if no software TTC is being used then

    4) Add a transition-time-converter module (TTC) onto each of the six TMDS_DATA signals with a value that causes the signal slew rate to match the slew rate of the leading edges of the HDMI-specified TP1 eye diagram. Add TTCs to the TMDS_CLOCK outputs, as needed, to create a TMDS rise/fall time between 75pS and 110pS.

5) Connect the Agilent E4887A to the input TPA-R.

- Attach Bias-Tees to each Agilent ParBERT output and connect Bias-Tee “DC” input to power supply at 3.1V.
- Attach Transition Time Converter for tested frequency to each Bias-Tee’s output.
- Clockgroup A, Channel 1+, 1–: connect to TMDS_CLOCK+, –
- Clockgroup B Channel 1+, 1–: connect to TMDS_DATA0+, – (“DATA0_P”, “DATA0_N”)
- Clockgroup B, Channel 2+, 2–: connect to TMDS_DATA1+, –
- Clockgroup B, Channel 3+, 3–: connect to TMDS_DATA2+, –

- Clockgroup B Channel 4+, 4–: No connect

6) Connect Oscilloscope to “input” TPA-R by using a TPA-P with two Differential Probes. Supply 3.3V power to the probes.

Perform the steps in the Required Test Method.

Note: The setup drawings above shows the testing configuration for the output measurement steps. For the eye calibration steps, use a TPA-P on the oscilloscope, connected directly to the “input” TPA-R from the TMDS Signal Generator.

5.3 Cable – Electrical: Parametric Tests

The tests in this section correspond to the cable parameters specified in [HDMI: Table 4-21] "Cable Assembly Parameters".

Test ID 5-4: Intra-Pair Skew

Reference	Requirement
[HDMI: Table 4-21] Cable Assembly Parameters	Cable Assembly Intra-Pair Skew should be no more than 151ps.

Test Objective

Confirm that the Cable Assembly does not have intra-pair skew on the TMDS lines greater than that allowed in the specification.

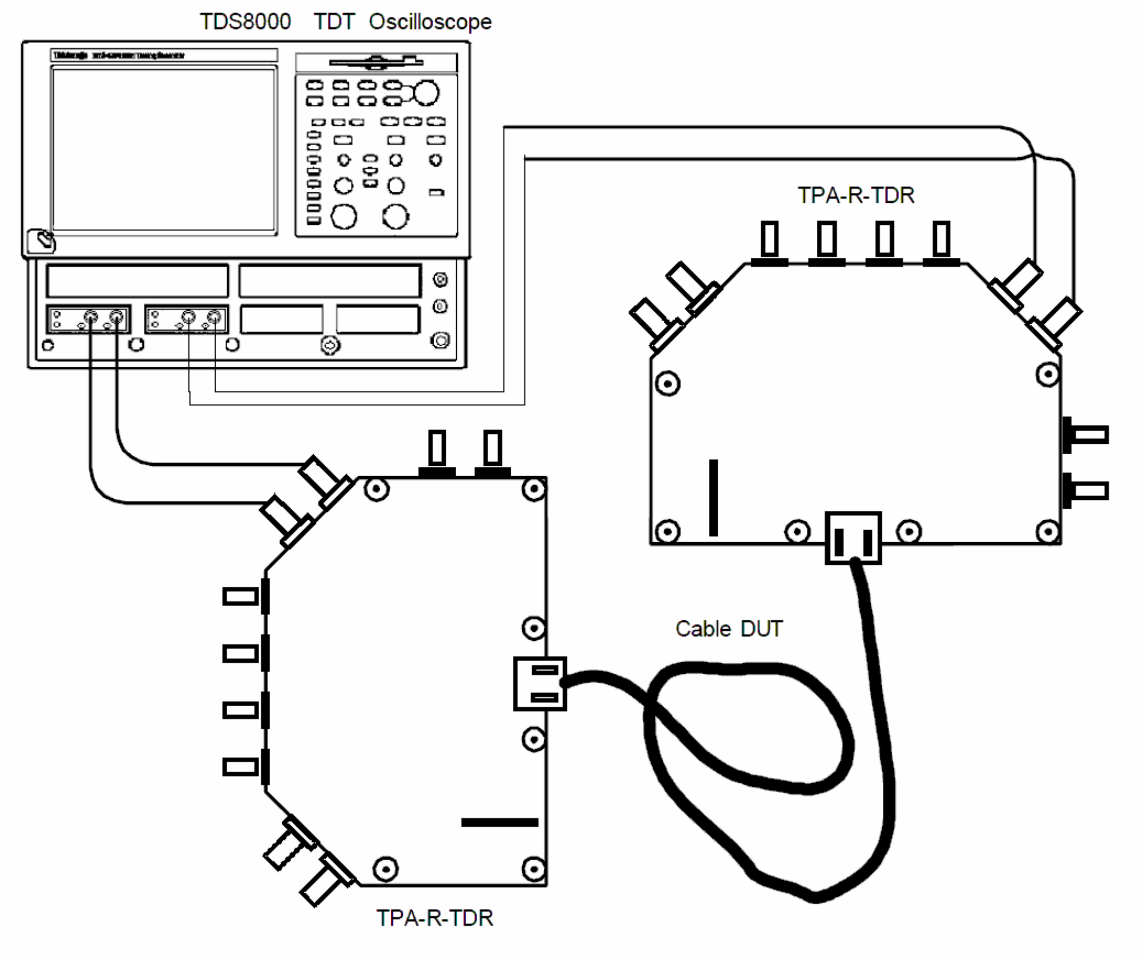
Required Test Method

For ATC testing, this test is always recommended. For self-testing, this test shall be performed if the Adopter is unable to perform Test ID 5-3 above.

If all tests in section 5.2 have passed then a FAIL on this test does not constitute an overall testing failure.

1) If CDF field Cable_Category is neither 1 nor 2 then FAIL.
2) De-skew the measurement equipment according to the manufacturer's recommended procedure.
3) Connect one TPA-R adapter to each end of Cable DUT.
4) Connect operator to anti-static strap.
5) Connect TDT output (stimulus) channel + side to TMDS_DATA0+ and – side to TMDS_DATA0- pins of input TPA-R adapter.
6) Connect TDT input channel + side to TMDS_DATA0+ and – side to TMDS_DATA0- pins of output TPA-R adapter.
7) Configure TDT to measure the two single-ended signals on channel #2.
8) Set vertical axis to 100 mV/Div and horizontal axis to 100 psec/Div.
9) Measure skew (delay between inputs on channel 2), T_{IPSKEW}, using TDT oscilloscope. Measurement point is absolute voltage +125mV of + side of input channel and -125mV of – side of input channel.
10) If the CDF field Cable_Category is 1
    11) If (T_{IPSKEW} > 151ps) then FAIL.
12) Else (CDF field Cable_Category is not 1)
    13) If (T_{IPSKEW} > 111ps) then FAIL.
14) Repeat the test on the remaining TMDS pairs.

Recommended Test Method – Tektronix Test ID 5-4: Intra-Pair Skew



Setup 4. Test ID 5-4: Intra-Pair Skew: Tektronix

No.	Description	Recommended TE	Reference	Qty.
1	TDR/TDT Oscilloscope	Tektronix TDS8200B	4.2.1.11	1
2	SMA Cables	<See reference>	4.2.1.7	4
3	TPA-R-SMA Fixture	Tektronix TPA-R-TDR or EFF-HDMI-TPA-R	4.2.1.1.7	2

Perform the Required Test Method using the Recommended Test Equipment shown above.

Test ID 5-5: Inter-Pair Skew

Reference	Requirement
[HDMI: Table 4-21] Cable Assembly Parameters	Cable Assembly Inter-Pair Skew should be no more than 2.42ns

Test Objective

Confirm that the Cable Assembly does not have inter-pair skew on the TMDS lines greater than that allowed in the specification.

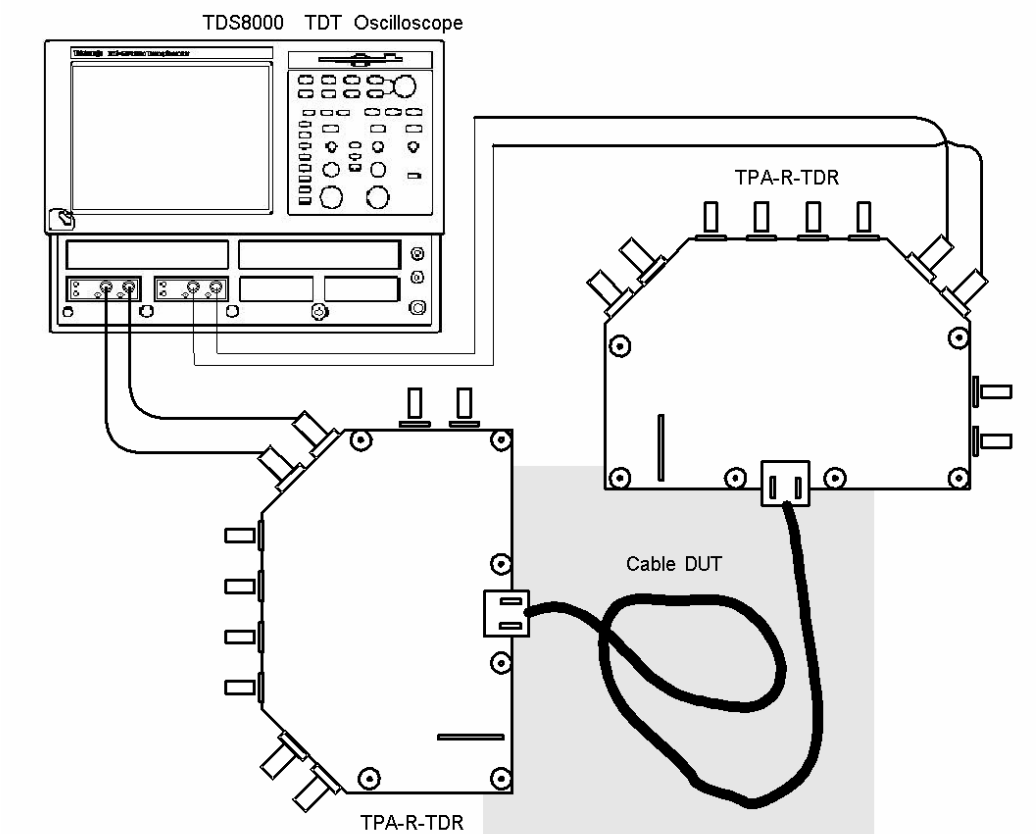
Required Test Method

For ATC testing, this test is always recommended. For self-testing, this test shall be performed if the Adopter is unable to perform Test ID 5-3 above.

If all tests in section 5.2 have passed then a FAIL on this test does not constitute an overall testing failure.

1) De-skew the measurement equipment according to the manufacturer's recommended procedure
2) Connect one TPA-R adapter to each end of Cable DUT.
3) Set vertical axis to 100 mV/Div and horizontal axis to 100 psec/Div.
4) Configure TDT to measure the differential signal.
5) For each TMDS differential pair (TMDS_CLOCK, DATA0, DATA1…) perform the following:
    5.1) Connect TDT output channel to + and - pins of tested TMDS pair on input TPA-R adapter using SMA cables.
    5.2) Connect TDT input channel to + and - pins of tested TMDS pair on output TPA-R adapter using SMA cables.
    5.3) Measure the waveform and save for later analysis.
6) Inter-pair Skew measurement point must be 50% of the amplitude of the driven step pulse (consult TDT equipment specifications for this value). Measure skew (delay between saved waveforms), T_{XPSKEW}, for every combination of channels. This can be done in one operation by overlaying all four saved waveforms and noting left-most and right-most edges.
7) If the CDF field Cable_Category is 1 then
    8) If (T_{XPSKEW} > 2.42ns) then FAIL
9) If the CDF field Cable_Category is 2 then
    10) If (T_{XPSKEW} > 1.78ns) then FAIL
11) Repeat the test on the remaining TMDS pairs.

Recommended Test Method — Test ID 5-5: Inter-Pair Skew



Setup 5. Test ID 5-5: Inter-Pair Skew: Tektronix

No.	Description	Recommended TE	Reference	Qty.
1	TDR/TDT Oscilloscope	Tektronix TDS8200B	4.2.1.11	1
2	SMA Cables	<See reference>	4.2.1.7	4
3	TPA-R-SMA Fixture	Tektronix TPA-R-TDR or EFF-HDMI-TPA-R	4.2.1.1.7	2

Perform Required Test Method using Recommended Test Equipment shown above.

Test ID 5-6: Far End Crosstalk

Reference	Requirement
[HDMI: Table 4-21] Cable Assembly Parameters	Cable Assembly far end crosstalk should be less than –20dB.

Test Objective

Confirm that the Cable Assembly does not have crosstalk at the far-end between the TMDS lines greater than that allowed in the specification.

Required Test Method

For ATC testing, this test is always recommended. For self-testing, this test shall be performed if the Adopter is unable to perform Test ID 5-3 above.

If all tests in section 5.2 have passed then a FAIL on this test does not constitute an overall testing failure.

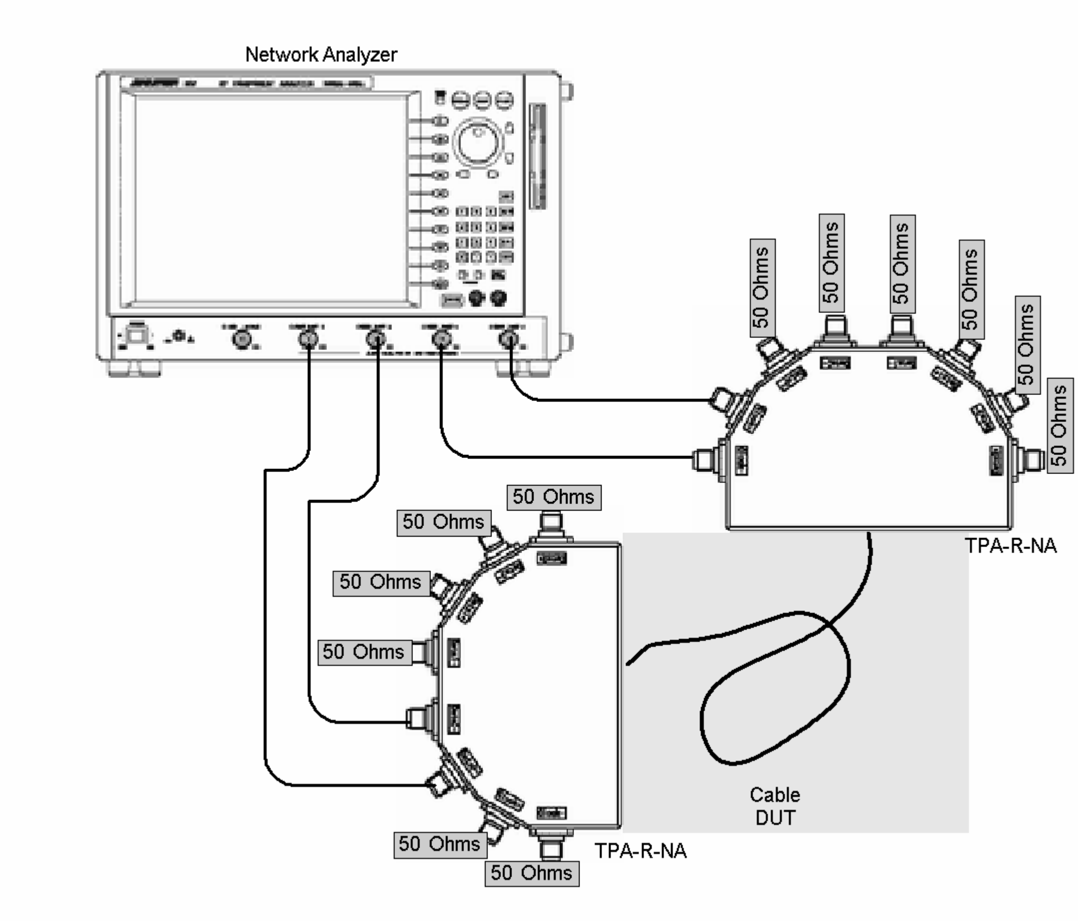
Setup:

1) Setup the network analyzer with measurement frequency range of 300kHz to 5GHz. IF bandwidth is not critical.
2) Calibrate the NA using a 4-port auto-calibration kit, or a standard calibration kit.
3) Calibrate NA, including SMA and TPA fixture, using a port extension function. Less than ±10 degrees at 2.475GHz.

Measure Crosstalk:

4) Connect input end of cable to first TPA-R adapter.
5) Connect output end of cable to second TPA-R adapter.
6) Connect Network Analyzer ports 1 and 2 to the input TPA-R fixture, TMDS_CLOCK channel + and – respectively.
7) Connect Network Analyzer ports 3 and 4 to the output TPA fixture, TMDS_DATA0 + and – respectively.
8) Connect a 50Ω terminator to each of the untested TMDS signals.
9) Measure the crosstalk and find the maximum value (X_{FE})
10) If $X_{FE} \geq$ -20dB then FAIL.
11) Repeat the measurement for all remaining combinations of TMDS pairs:
    - CLOCK, DATA0
    - CLOCK, DATA1
    - CLOCK, DATA2
    - DATA0, DATA1
    - DATA0, DATA2
    - DATA1, DATA2

Recommended Test Method – ADVANTEST Test ID 5-6: Far End Crosstalk



Setup 6. Test ID 5-6: Far End Crosstalk: ADVANTEST

No.	Description	Recommended TE	Reference	Qty.
1	Network Analyzer (NA)	ADVANTEST R3860A	4.2.1.10	1
2	SMA Cables	<See reference>	4.2.1.7	4
3	50Ω SMA Terminators	<See reference>	4.2.1.8	12
4	TPA-R-NA Fixture	ADVANTEST CAX-ATI013	4.2.1.1.8	2

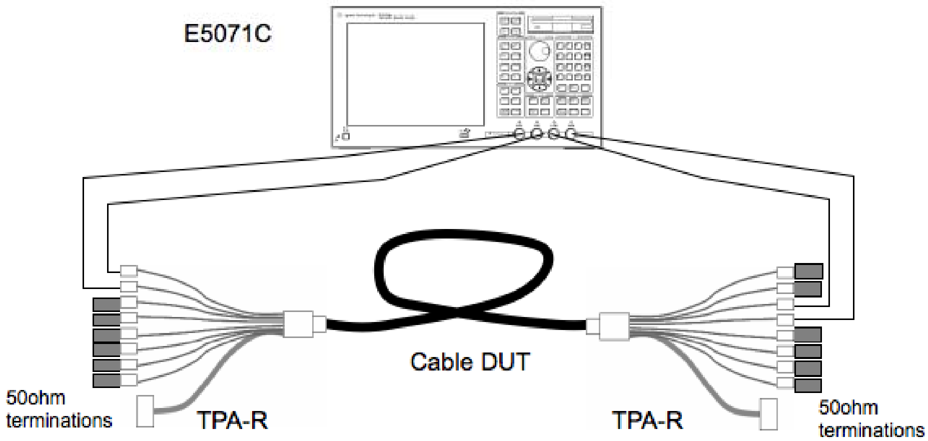
1) Setup the ADVANTEST analyzer with 1601 measurement points, measurement frequency range of 300kHZ to 5GHz. IF bandwidth is not critical.

2) Calibrate the NA using a 4-port auto-calibration kit, or a standard calibration kit.

3) Calibrate NA, including SMA and TPA fixture, using a port extension function. Less than ±10 degrees at 2.475GHz.

Perform the Required Test Method starting with “Measure Crosstalk:”.

Recommended Test Method – Agilent Test ID 5-6: Far End Crosstalk



Setup 7. Test ID 5-6: Far End Crosstalk: Agilent

No.	Description	Recommended TE	Reference	Qty.
1	Network Analyzer (NA)	Agilent E5071C	4.2.1.10	1
2	SMA Cable and adapter, as needed	<See reference>	4.2.1.7	4
3	50ohm SMA Terminator	<See reference>	4.2.1.8	12
4	TPA-R-SMA Fixture	Agilent N1080A H02	4.2.1.1.3	2

1) Setup the Network Anayzer with 1601 measurement points, measurement frequency range of 300kHz to 5GHz. IF bandwidth is not critical.
2) Calibrate the NA using a 4-port E-cal module, or standard calibration kit.
3) Calibrate NA, including SMA and TPA, using port extension function.

Perform the Required Test Method starting with “Measure Crosstalk:”.

Test ID 5-7: Attenuation and Phase

Reference	Requirement
[HDMI: Table 4-21] Cable Assembly Parameters	See reference for details.
[HDMI: Appendix G]	See reference for details.

Test Objective

Confirm that the Cable Assembly does not have attenuation and phase on the TMDS lines greater than that allowed in the specification.

Required Test Method

For ATC testing, this test is always recommended. For self-testing, this test shall be performed if the Adopter is unable to perform Test ID 5-3 above.

If all tests in section 5.2 have passed then a FAIL on this test does not constitute an overall testing failure.

Setup:

1) If CDF field Cable_Category is neither 1 nor 2 then FAIL.
2) Connect input end of cable to first TPA-R adapter.
3) Connect output end of cable to second TPA-R adapter.
4) Setup the network analyzer with measurement frequency range of 300kHz to 5GHz. IF bandwidth is not critical.
5) Calibrate the NA using a 4-port auto-calibration kit, or a standard calibration kit.
6) Calibrate NA, including SMA and TPA fixture, using a port extension function. Less than ±10 degrees at 2.475GHz.

Measure Attenuation:

7) Connect Network Analyzer ports 1 and 2 to the input TPA fixture, TMDS Clock channel '+' and '–' respectively.
8) Connect Network Analyzer ports 3 and 4 to the output TPA fixture, TMDS Clock channel '+' and '–' respectively.
9) Connect a 50Ω terminator to each of the untested TMDS signals.
10) Measure the attenuation using SDD21 log-mag (S-parameter, S-matrix component number 2-1, differential-to-differential).

11) If CDF field Cable_Type is Wire then use HDMI Spec Figure 4-22 for Category 1 cable and Figure 4-23 for Category 2 cable for attenuation limits.

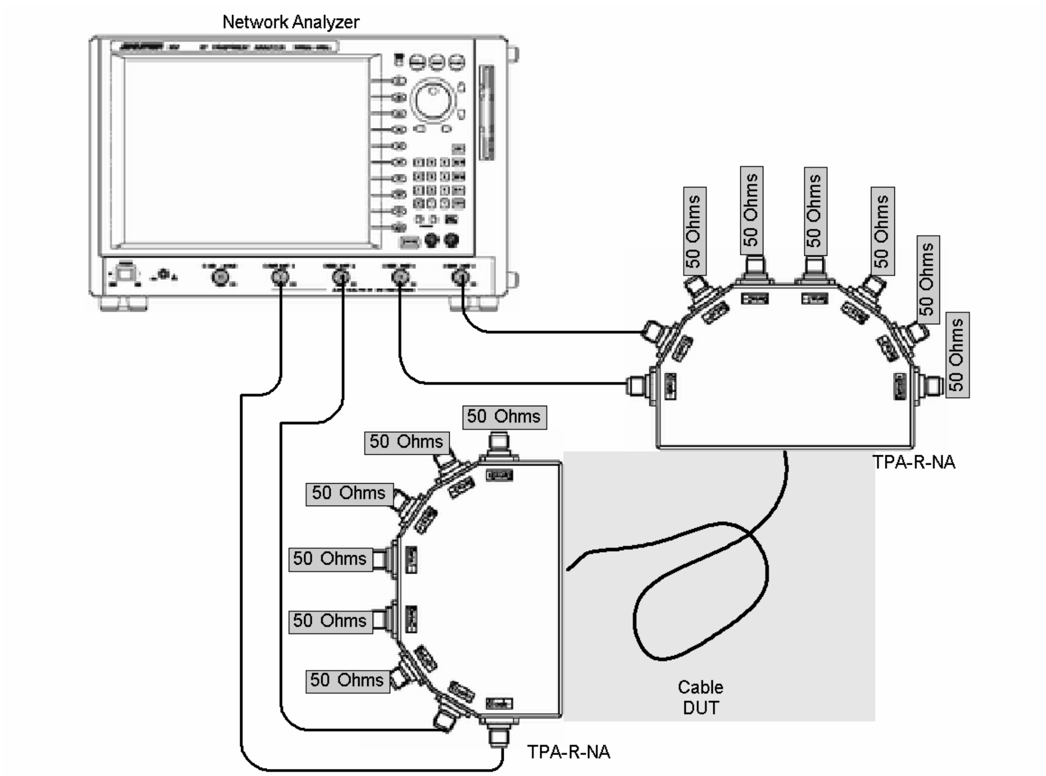
12) If the measured attenuation curve falls below the limits at any point then FAIL.

13) If CDF field Cable_Type is Passive, use HDMI Spec Figure G-1 and G-3 for attenuation and phase curves.

14) If the measured attenuation or phase curve violates the shaded area at any point then FAIL.

15) Repeat the measurement for remaining TMDS channels.

Recommended Test Method – ADVANTEST Test ID 5-7: Attenuation and Phase



Setup 8. Test ID 5-7: Attenuation and Phase: ADVANTEST

No.	Description	Recommended TE	Reference	Qty.
1	Network Analyzer (NA)	ADVANTEST R3860A	4.2.1.10	1
2	SMA Cables	<See reference>	4.2.1.7	4
3	50Ω SMA Terminators	<See reference>	4.2.1.8	12
3	TPA-R-NA Fixture	ADVANTEST CAX-ATI013	4.2.1.1.8	2

1) Setup the ADVANTEST analyzer with 1601 measurement points, measurement frequency range of 300kHz to 5GHz. IF bandwidth is not critical.

2) Calibrate the NA using a 4-port auto-calibration kit, or a standard calibration kit.

3) Calibrate NA, including SMA and TPA fixtures, using a port extension function. Less than ±10 degrees at 2.475GHz is required.

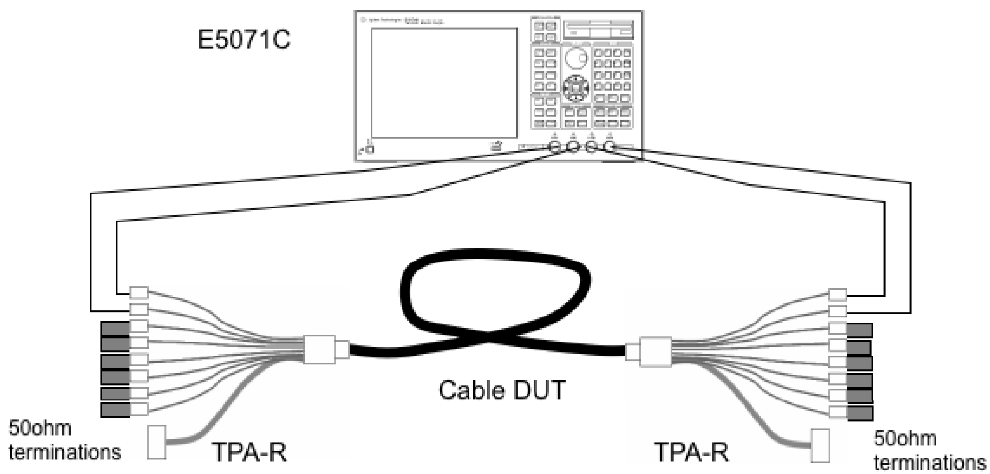
Perform the Required Test Method starting with "Measure Attenuation."

Note that, in case of the phase differential measurement, phase is measured using u-phase mode The data saved as CSV format will be analyzed by PC software as follows.

Approximate linear line is calculated by using the method of least squares

- Frequency range is from 300K to 1.7GHz.
- The phase value equals to zero at zero crossing point

Recommended Test Method – Agilent Test ID 5-7: Attenuation and Phase



Setup 9. Test ID 5-7: Attenuation and Phase: Agilent

No.	Description	Recommended TE	Reference	Qty.
1	Network Analyzer (NA)	Agilent E5071C	4.2.1.10	1
2	SMA Cable and adapter, as needed	<See reference>	4.2.1.7	4
3	50ohm SMA Terminator	<See reference>	4.2.1.8	12
4	TPA-R-SMA Fixture	Agilent N1080A H02	4.2.1.1.3	2

1) Connect input end of cable to first TPA-R.

2) Connect output end of cable to second TPA-R.

3) Setup the network analyzer with measurement frequency range of 300kHz to 5GHz. IF bandwidth is not critical.

4) Calibrate the NA using a 4-port E-cal module, or a standard calibration kit.

5) Calibrate NA, including SMA and TPA fixture, using a port extension function..

Perform the Required Test Method starting with “Measure Attenuation:”.Note that, in case of the phase differential measurement, use the automated HDMI cable measurement mode.

Test ID 5-8: Differential Impedance

Reference	Requirement
[HDMI: Table 4-21] Cable Assembly Parameters	Cable Assembly differential impedance should be: 100Ω±15%, measured at connector area, and 100Ω±10%, measured at the cable area.

Test Objective

Confirm that the Cable Assembly does not have differential impedance on the TMDS lines outside the tolerances allowed in the specification.

Required Test Method

For both ATC and self testing, this test is always required.

1) Connect near end of cable to first TPA-R adapter.
2) Connect far end of cable to second TPA-R adapter.
3) Connect 50Ω terminators to all TMDS + and – signals on the far-end TPA-R.
4) Connect SMA cable from TDR oscilloscope to TMDS_DATA0+ on near-end TPA-R.
5) Connect 50Ω terminators to all untested TMDS signals on near-end TPA-R.
6) Configure the TDR oscilloscope to measure differential impedance in TDR mode:
    6.1) TDR effective rise time = 200ps (determined by using the test coupon on TPA-R, if available). Note that many TDRs use a much faster actual rise time and use a digital filter to attain the effective near-200psec rise time.
    6.2) Vertical axis set to ‘ohms (Ω)’.
7) View the TDR trace of impedance, Z_{DIFF}, on TMDS_DATA0+:

    $Z_{DIFF\_CONN\_LOW}$ = lowest impedance through the connector and transition area (up to 1ns max)

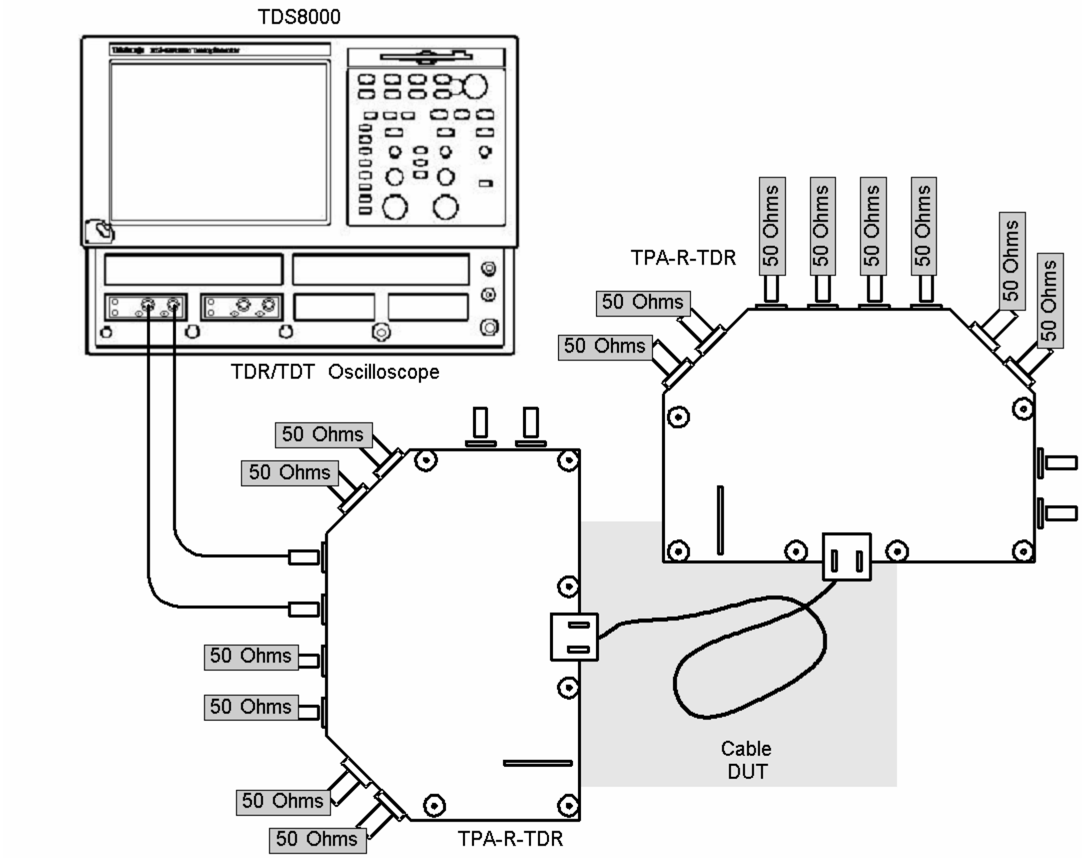
    $Z_{DIFF\_CONN\_HI}$ = highest impedance through the connector and transition area (up to 1ns max)

    $Z_{DIFF\_CABLE\_LOW}$ = lowest impedance in the cable area (1ns to 2.5ns)

    $Z_{DIFF\_CABLE\_HI}$ = highest impedance in the cable area (1ns to 2.5ns)

    8) If ($Z_{DIFF\_CABLE\_LOW}$ < 90Ω) OR ($Z_{DIFF\_CABLE\_HI}$ > 110Ω) then FAIL.
    9) If ($Z_{DIFF\_CONN\_LOW}$ < 75Ω) OR ($Z_{DIFF\_CONN\_HI}$ > 125Ω) then FAIL.
    10) If ($Z_{DIFF\_CONN\_LOW}$ < 85Ω) OR ($Z_{DIFF\_CONN\_HI}$ > 115Ω) then
        11) If the duration of violation is 250psec or longer or there is more than one excursion then FAIL
12) Repeat the test for all remaining + and - TMDS signals.
13) If cable is not unidirectional (CDF field Cable_Unidirectional = “N”) then swap near and far-end TPA-R and repeat the test, otherwise end test.

Recommended Test Method – Tektronix Test ID 5-8: Differential Impedance



Setup 10. Test ID 5-8: Differential Impedance: Tektronix

No.	Description	Recommended TE	Reference	Qty.
1	TDR/TDT Oscilloscope	Tektronix TDS8200B	4.2.1.11	1
2	SMA Cables	<See reference>	4.2.1.7	2
4	50Ω SMA Terminators	<See reference>	4.2.1.8	14
3	TPA-R-SMA Fixture	Tektronix TPA-R-TDR or EFF-HDMI-TPA-R	4.2.1.1.7	2

Perform the Required Test Method using the Recommended Test Equipment shown above.

Note that the Tekronix TDR uses a much faster actual rise time and uses a digital filter to attain the effective near-200psec rise time.

5.4 Cable – Active Cable Tests

Test ID 5-9: Active Cable Basic Functionality

Test Objective

Verify that active cables pass additional requirements.

Required Test Method

1) Perform test 5-3 using a Vicm of 3.3V.

Remaining steps are preliminary and should be considered informative.

2) Connect EDID Analyzer to the DUT and connect the DUT to any EDID Emulator.
3) Connect output of cable DUT to QD “input”.
4) Perform test 8-10.
5) Verify that CEC signals can pass through cable from both directions.
6) If the current on +5V Power ever exceeds 5 mA then FAIL
7) Confirm that HPD signal is correctry transferred. If not, then FAIL

6 Tests – Plug and Receptacle

The following tests must be run on individual connector samples at a facility equipped for such testing. The adopter may have this testing performed by the supplier of the connector. All HDMI connectors on Cable Assemblies, Sources, Sinks and Repeaters shall be capable of passing all of the tests in this section.

Note that all connectors shall be tested at a qualified facility of the system or connector vendor's choosing. HDMI Licensing LLC maintains an approved list of connectors which have passed such testing. To have a connector placed on the approved list, the vendor must submit full and passing test results to the ATC or directly to HDMI Licensing LLC. The ATC will fail products submitted with connectors that are not on the approved list. Note that the connectors are specified in the CDF under "Connector Vendor Name" and "Connector Model Name/ID."

6.1 Mechanical Tests

Test ID 6-1: Connector Mechanical Specification

Reference	Requirement
[HDMI: 4.1.9] Connector Drawings	<See reference for details.>

Test Objective

Verify that plug mechanical dimensions are within specified tolerances.

Required Test Method

- ❑ Measure the following dimensions: all mating surfaces of: shell, pins, insulators, and contacts.
- ❑ Connector dimensions shall be within tolerances shown in relevant figures. [HDMI: Figure 4-1 through Figure 4-6]

Recommended Test Method

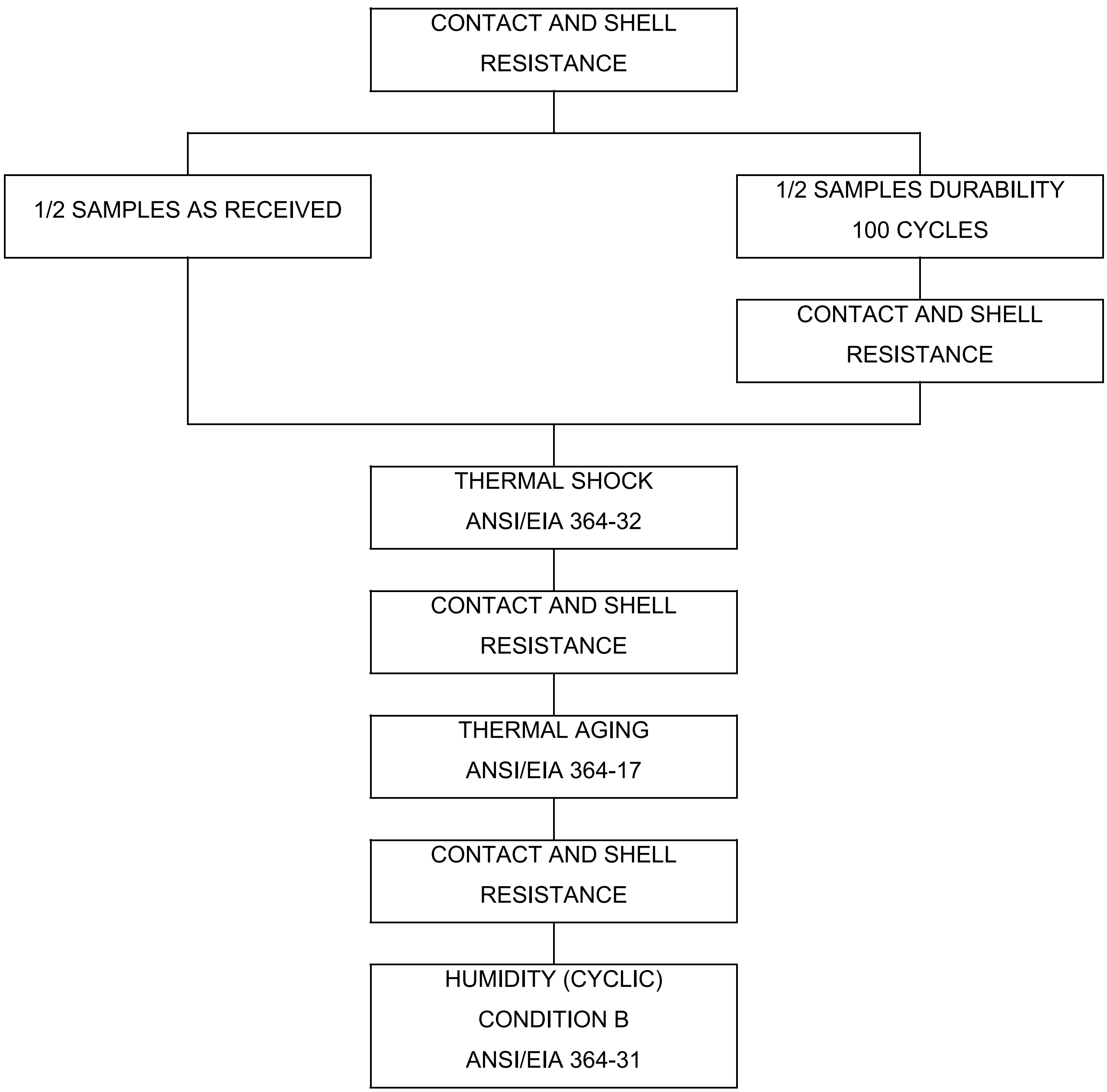
Perform steps in Required Test Method above.

6.2 Connector – ANSI 364 Tests

Tested using ANSI/EIA 364. Refer to [HDMI: 4.1.6, 4.1.7 and 4.1.8] for parameter to be measured.

Reference	Requirement
ANSI/EIA 364	<See reference for details.>
[HDMI: 4.1.6, 4.1.7 and 4.1.8]	<See reference for details.>

Test ID 6-2: GROUP1: Environmental Performance



CONTACT AND SHELL RESISTANCE

Number of Samples

6 : Receptacle assembled to printed circuit board.

6 : Cable assemblies with a plug assembled to one end, 50.8mm long.

Test ID 6-3: GROUP2: Mated Mechanical

CONTACT AND SHELL RESISTANCE

VIBRATION
ANSI/EIA 364-28

CONTACT AND SHELL RESISTANCE

MECHANICAL SHOCK
ANSI/EIA 364-27

CONTACT AND SHELL RESISTANCE

Number of Samples

2 : Receptacle assembled to printed circuit board.

2 : Cable assemblies with a plug assembled to one end, 50.8mm long.

Test ID 6-4: GROUP 3 Insulator Integrity

DIELECTRIC
WITHSTANDING VOLTAGE
ANSI/EIA 364-20

THERMAL SHOCK
ANSI/EIA 364-32

DIELECTRIC
WITHSTANDING VOLTAGE
ANSI/EIA 364-20

INSULATION RESISTANCE
ANSI/EIA 364-21

HUMIDITY (CYCLIC)
CONDITION A
ANSI/EIA 364-31

INSULATION RESISTANCE
ANSI/EIA 364-21

Number of Samples

2 : Receptacle assembled to printed circuit board.

2 : Cable assemblies with a plug assembled to one end, 50.8mm long.

Test ID 6-5: GROUP 4 Cable Flexing

CABLE FLEXING
ANSI/EIA 364-41

DIELECTRIC
WITHSTANDING VOLTAGE
ANSI/EIA 364-20

INSULATION RESISTANCE
ANSI/EIA 364-21

Number of Samples

2 : Cable assemblies.

Test ID 6-6: GROUP 5 Electrostatic Discharge

ELECTROSTATIC DISCHARGE

Number of Samples

1 : Receptacle connector.

1 : Plug Cable

7 Tests – Source

7.1 Source Products Overview

In order to be adequately tested, the Source (DUT) shall have the ability to output an HDMI signal that is indicative of the behavior of the Source DUT during normal user operation. For instance,

- If the DUT is a DVD player or similar device, the operator may use the ability of the DUT to playback pre-recorded or recorded media (disk, tape, etc) in order to output the HDMI video test signal.
- If the DUT is a set-top box or similar device, the operator may use the ability of the DUT to decode a received signal in order to output the HDMI video test signal.
- The operator may use a menu mode or other user interface on the DUT in order to output an HDMI signal.

The Source device needs to output an HDMI signal as specified in the test. This procedure will be product-specific but will likely be accomplished by presenting specific EDID images to the Source, manually configuring the Source and/or by supplying certain media or content into the Source. In many cases, this effort can be assisted by configuring an EDID present in the test equipment (analyzer) to indicate support for each of the formats supported by the Source.

7.2 Source – EDID / E-DDC / HPD

Test ID 7-1: EDID-Related Behavior

Reference	Requirement
[HDMI: 8.4.5] Enhanced DDC Source	"The Source shall use Enhanced DDC protocols. The Source reads Enhanced EDID extensions data at DDC address 0xA0 using segment pointer 0x60."
[HDMI: 8.3] EDID Data Structure	"A Source shall read the EDID 1.3 and first CEA EDID Timing Extension to determine the capabilities supported by the Sink."

Test Objective

Verify that Source supports the reading of the EDID 1.3 block and first CEA EDID Timing Extension from both 2- and 4-block EDIDs.

Required Test Method

- Attach Source DUT to EDID Emulator.
- Power-on the EDID Emulator. Ensure that 3.3V termination power is applied to the TMDS signals.
- Attach I^2C Analyzer to SDA and SCL signals either directly to EDID Emulator, through a TPA board, or some other method.
- Turn on Source DUT
- Configure I^2C Analyzer to capture and analyze all I^2C transactions.
- Configure EDID Emulator for 750pF total capacitance (emulator plus cable plus probes, etc.) and nominal pull-up resistance on SDA and SCL.

- Apply a valid HDMI EDID containing the following 2 blocks:
  - 0: EDID 1.3
1: CEA Timing Extension version 3
containing an HDMI VSDB of a length >=6
- Pulse HPD low for more than 100msec
- Examine I^2C transactions occurring after HPD pulse.
- If I^2C commands do not perform full read of EDID blocks 0 and 1 then FAIL

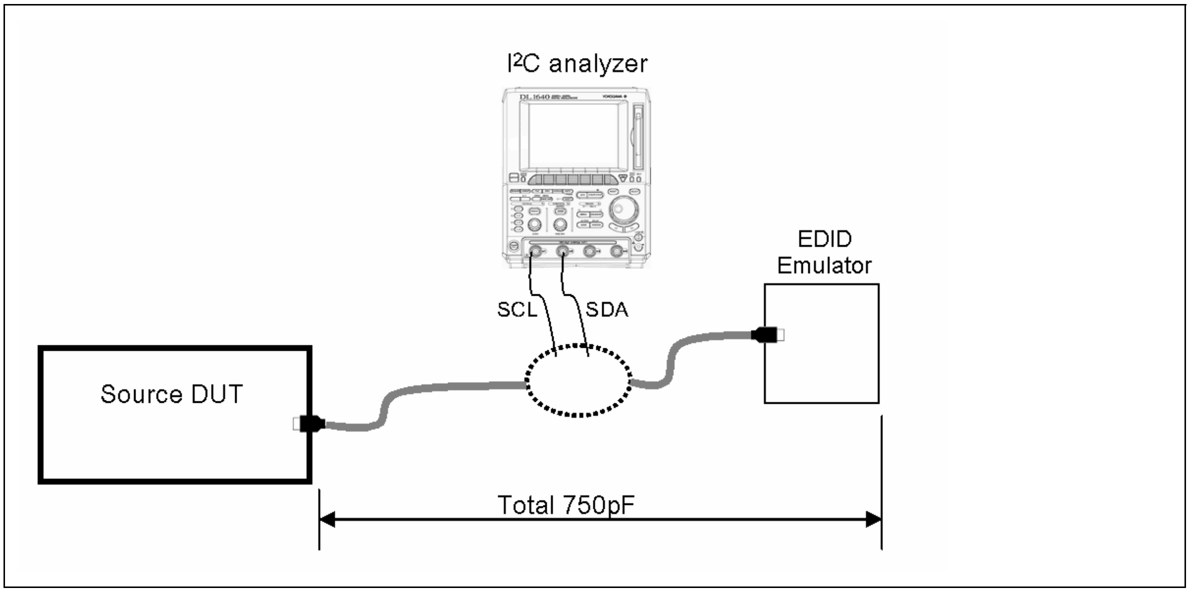
- If SCL frequency exceeds 100kHz (less than 10microseconds between rising edges) then FAIL

- Apply a valid HDMI EDID containing the following 4 blocks:
  - 0: EDID 1.3
1: Extension Map

2: CEA Timing Extension version 3 (includes HDMI VSDB, length >=6)
3: CEA Timing Extension version 3 (single DTD)

- ❑ Pulse HPD low for more than 100msec
- ❑ Examine I^{2}C transactions occurring after HPD pulse.
- ❑ If I^{2}C commands do not perform full read of EDID blocks 0 and 2 then FAIL

Recommended Test Method — Test ID 7-1: EDID-Related Behavior



Setup 11. Test ID 7-1: EDID-Related Behavior

No.	Description	Recommended TE	Reference	Qty.
1	I^{2}C Analyzer	<See reference>	4.2.3.3	1
2	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
3	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
4	Additional capacitance	<As needed to reach 750pF total>		1

1) Attach Source DUT to EDID Emulator using a short (<1meter) HDMI cable.
2) Connect probes of I^{2}C Analyzer to SDA and SCL signals either through a TPA board, directly to EDID Emulator or some other method.
3) Power on EDID Emulator. Using a short cable, connect a display to the downstream port of the EDID Emulator and turn the display on.
4) Turn on Source DUT.
5) Configure oscilloscope:
   - I^{2}C mode is selected
   - Trigger is set to “Single shot” mode.
   - Triggering pattern is set to “address = 0xA0”.
6) Configure I^{2}C Analyzer to capture and analyze all I^{2}C transactions.

7) Configure EDID Emulator capacitance so that total capacitance of Emulator and HDMI cable is 750pF. Configure EDID Emulator to have nominal pull-up resistance on SDA and SCL.

8) Apply a valid HDMI EDID containing the following 2 blocks:

- 0: EDID 1.3
  1: CEA Timing Extension version 3 (includes HDMI VSDB, length >=6)

9) Pulse HPD for more than 100msec

10) If no oscilloscope trigger occurs then FAIL

11) If oscilloscope capture does not contain: <0xA0+ack> <0x00+ack> RS <0xA1+ack> then FAIL

12) If I^2C commands do not perform full read of EDID blocks 0 and 1 then FAIL

13) If SCL frequency exceeds 100kHz (less than 10microseconds between rising edges) then FAIL

14) Apply a valid HDMI EDID containing the following 4 blocks:

- 0: EDID 1.3
  1: Extension Map
  2: CEA Timing Extension version 3 (includes HDMI VSDB, length >=6)
  3: CEA Timing Extension version 3 (single DTD)

15) Pulse HPD low for more than 100msec

16) If no oscilloscope trigger occurs then FAIL

17) If oscilloscope capture does not contain: <0x60+ack> <0x01+ack> RS <0xA0+ack> then FAIL

18) If I^2C commands do not perform full read of EDID blocks 0 and 2 then FAIL

7.3 Source – Electrical

Test ID 7-2: TMDS –V_L

Reference	Requirement
[HDMI: Table 4-15] Source DC Characteristics at TP1	Single-ended low level output voltage, V_L: if attached Sink supports only <=165MHz : $(AV_{cc} – 600mVolts) \le V_L \le (AV_{cc} – 400mVolts)$ if attached Sink supports >165MHz : $(AV_{cc} – 700mVolts) \le V_L \le (AV_{cc} – 400mVolts)$

Test Objective

Confirm that DC voltage levels on the HDMI link are within specified limits for each TMDS signal.

Required Test Method

Setup:

1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Connect probe to TMDS_DATA0+. If using a differential probe, follow the manufacturer's instructions for use in measuring a single-ended signal.
3) Configure the EDID to indicate only 27MHz formats (480p and 576p, no Deep Color support) with the 640x480p Established Timings bit set.
4) Control the Source DUT to output a video format with lowest supported TMDS clock frequency (typically 27MHz).

Measure:

5) Capture 1000 or more repetitions, triggered at the vertical mid-point of the High-to-Low transition of a H-L-L-L bit sequence. Each capture must be of duration $3*T_{BIT}$.
6) Display the voltage (vertical) histogram on the scope, with the histogram data accumulated only from the last 2-bits of the H-L-L-L sequence.
7) Read the V_L value as the most common low-level voltage shown on the histogram.
8) If (V_L > 2.90V) OR (V_L < 2.70V) then
    9) Capture 10,000 repetitions, triggered at mid-point of waveform, of duration ≥ $2*T_{BIT}$ to get proper histograms.
    10) Display the voltage (vertical) histogram on the scope.
    11) If (V_L > 2.90V) OR (V_L < 2.70V) then FAIL
12) Repeat the test for all eight TMDS signals.

13) If CDF field Source_Above_165 then:
    14) Switch to an EDID that additionally indicates:
    - Support for 1080p50Hz and 60Hz
    - Deep Color 36-bits/pixel

- Max_TMDS_Clock of 225MHz (value = 225/5 = 45).

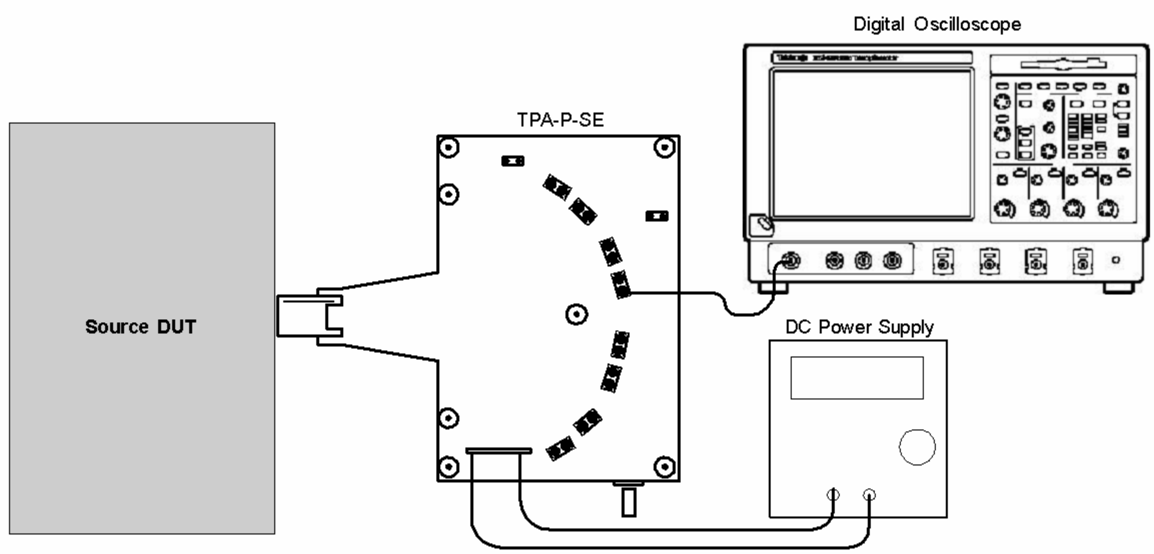
15) Repeat test sequence above still using lowest clock rate format.

16) If ($V_L > 2.90V$) OR ($V_L < 2.60V$) then FAIL

17) Repeat the test for all eight TMDS signals.

Recommended Test Method – Tektronix TDS7404 Test ID 7-2: TMDS –VBL

Because the measurement is at the lowest-supported frequency, the Tektronix TDS7404 may be used for all DUTs for this test.



Setup 12. Test ID 7-2: TMDS –VBL: Tektronix TDS7404

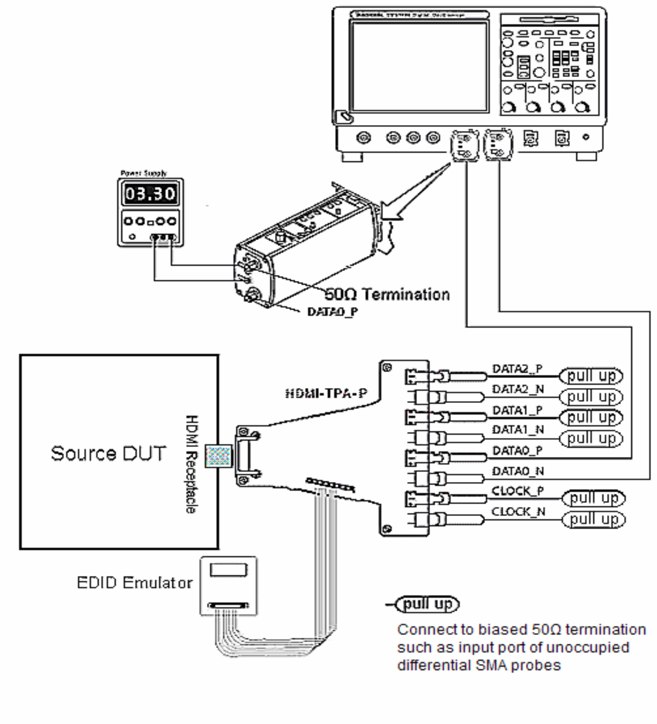
No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Single-Ended Probe	Tektronix P7240	4.2.1.6	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-SE Fixture	<See reference>	4.2.1.1.4	1

1) Connect TPA-P-SE adapter to Source DUT HDMI output connector.

2) Connect probe to TMDS_DATA0+.

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Tektronix DPO70804 Test ID 7-2: TMDS –VBL



Setup 13. Test ID 7-2: TMDS –VBL: Tektronix DPO70804

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL or DSA70804	4.2.1.3	1
2	Single-Ended Probe	Tektronix P7313SMA (configured to measure singled-ended signal)	4.2.1.6	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-SMA Fixture	<See reference>	4.2.1.1.4	1

1) Connect TPA-P adapter to Source DUT HDMI output connector.

2) Configure the P7313SMA probe to perform a single-ended measurement:

    3) Connect the + side of the P7313SMA probe to the measured signal, through a 50 ohm termination to 3.3V.

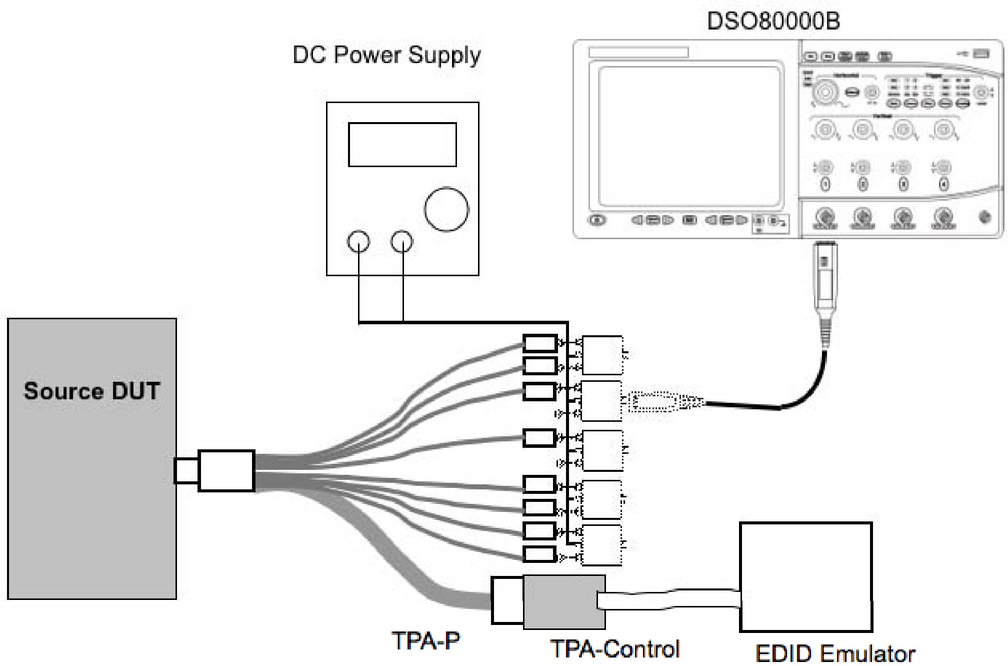
    4) Connect the – side of the probe to 3.3V through a 50 ohm termination. (This will offset the measurement to AVcc /2.)

    5) If performing the test manually, setup a math expression taking the resulting input and offset it by ½ Vterm. Refer to Tektronix documentation for more info. The test automation software normally will perform this operation.

6) Connect 50 ohm termination to remaining TMDS Clock and Data signals with 3.3V pullup. This can be done with additional probes.

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Agilent DSO80000B Test ID 7-2: TMDS –VBL



Setup 14. Test ID 7-2: TMDS –VBL: Agilent DSO80000B

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	1
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	5
4	DC Power Supply	<See reference>	4.2.1.15	1
5	EDID Emulator	Any recommended EDID emulator	4.2.3.2	1
6	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
7	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Connect the + side of the first SMA differential probe head (N5380A) with the differential probe amplifier (1169A) to TMDS_DATA0+. The - side of this SMA differential probe head is left open.
3) Connect the + side of the second SMA differential probe head to TMDS_DATA0- for termination. The - side of this SMA differential probe head is left open.
4) If performing this test manually configure the probe to perform a single-ended measurement. (The test automation software normally will perform these steps.)
   - Enter the probe setup menu:
     - Enable “External scaling” and set offset to 3.3V.

5) Connect three SMA differential probe heads to remaining TMDS Clock and Data pairs for termination.

Perform the Required Test Method with this setup. Agilent automation software may be used to automate the test sequence.

Test ID 7-3: TMDS – V_{OFF}

Reference	Requirement
[HDMI: Table 4-15] Source DC Characteristics at TP1	TMDS single-ended standby (off) output voltage, V_{OFF} must be within AVcc ±10mVolts.

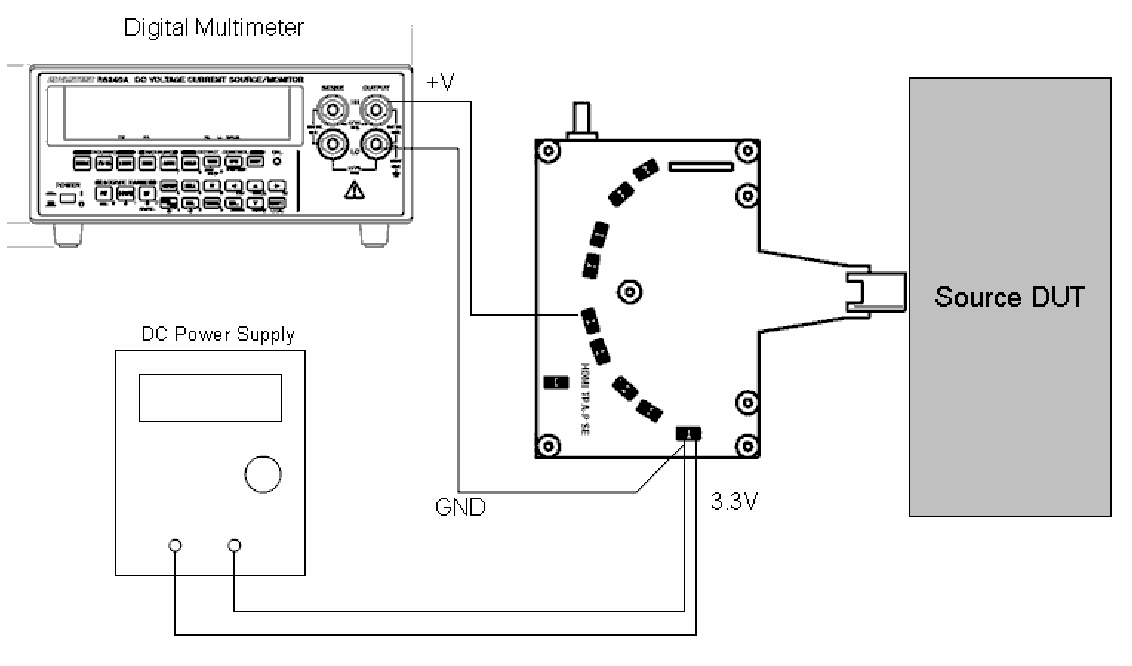
Test Objective

Confirm that a disabled TMDS link only allows leakage currents within specified limits.

Required Test Method

1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Supply 3.3V to the AV_{CC} side of the 50Ω pullups on the TPA-P adapter.
3) Disconnect DUT from AC mains or other power source.
4) Configure the Digital Multi-Meter to measure voltage.
5) Connect Digital Multi-Meter probes across the pull-up resistor on TMDS_DATA0+ (single-ended signal).
6) Measure voltage, V_{OFF}.
7) If $|V_{OFF}|$ > 10mV then FAIL.
8) Repeat measurement for all remaining TMDS Clock and Data, + and - signals.
9) Repeat the test with standby state if DUT disables its HDMI output in the standby state

Recommended Test Method — Test ID 7-3: TMDS – VBOFFB



Setup 15. Test ID 7-3: TMDS – VBOFFB

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
3	TPA-P-SE Fixture	<See reference>	4.2.1.1.4	1

Perform Required Test Method using test equipment shown above.

Test ID 7-4: TMDS – T_{RISE}, T_{FALL}

Reference	Requirement
[HDMI: Table 4-16] Source AC Characteristics at TP1	75psec ≤ Rise Time or Fall Time

Test Objective

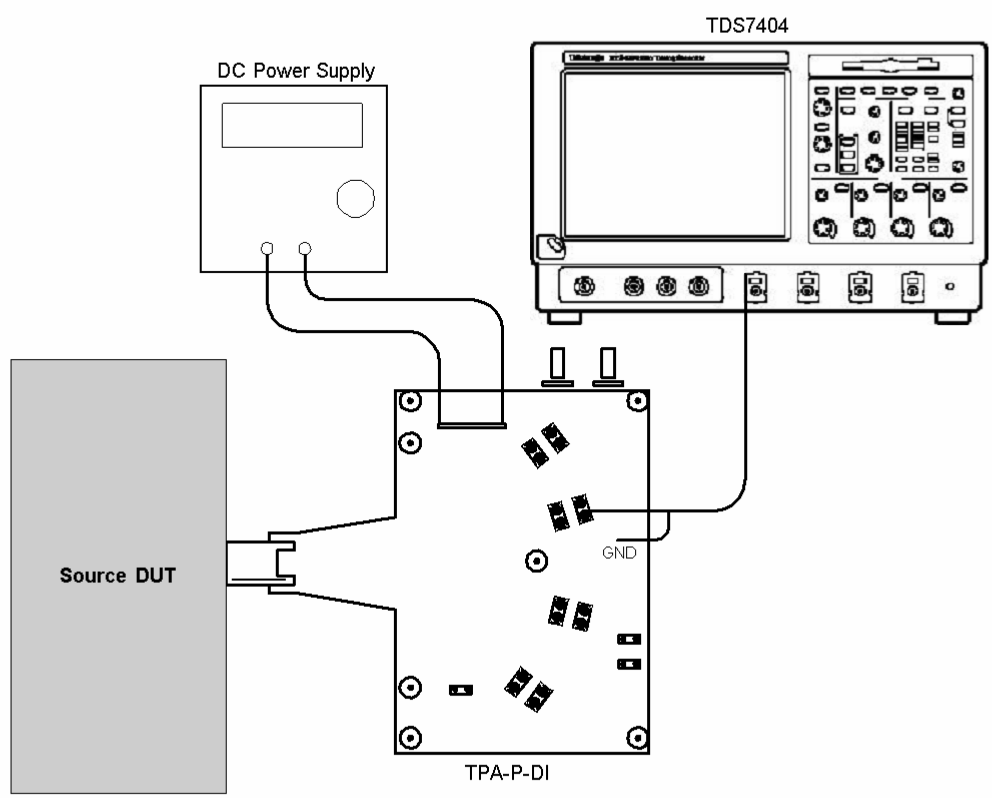
Confirm that the rise times and fall times on the TMDS differential signals fall within the limits of the specification.

Required Test Method

1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Configure Source DUT to output a video format and pixel size with highest supported TMDS clock frequency.
    3) Accumulate at least 10,000 triggered waveforms.
    4) Measure T_{RISE} as the mode of the sampled edge times from 20% to 80% of the differential swing voltage rising edge.
    5) Measure T_{FALL} as the mode of the sampled edge times from 80% to 20% of the differential swing voltage on the falling edge.
    6) If (T_{RISE} < 75ps) then FAIL.
    7) If (T_{FALL} < 75ps) then FAIL.
8) Repeat the test for all remaining TMDS clock and data pairs.

Recommended Test Method – Tektronix TDS7404

The following may only be used for testing of DUTs with a max supported TMDS clock frequency of 148.5MHz or less. For testing at 148.5MHz, it is better to use the alternative scopes below.

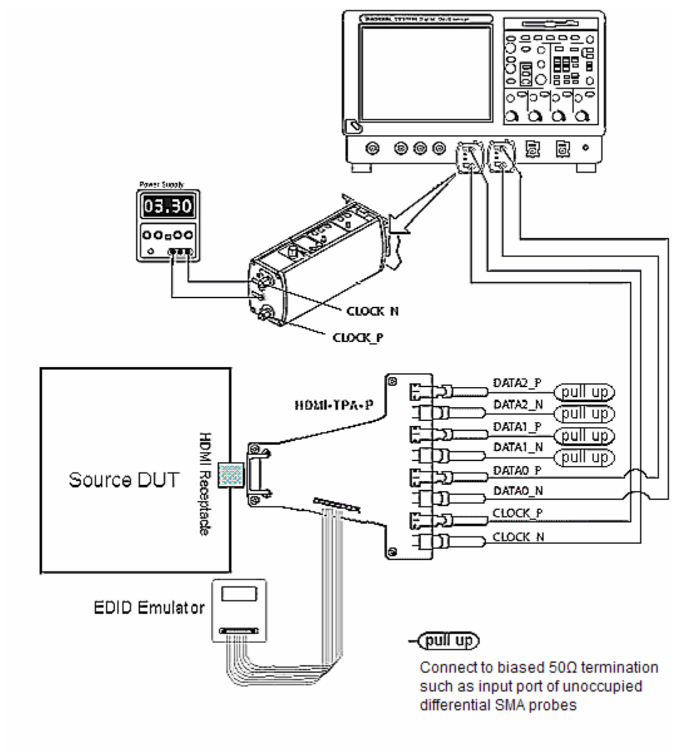


Setup 16. Test ID 7-4: TMDS – TBRISEB, TBFALLB: Tektronix TDS7404

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Differential Probe	Tektronix P7330 or Tektronix P7350SMA	4.2.1.4	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P Fixture	Tektronix TPA-P-DI or TPA-P-TDR or EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Tektronix DPO70804

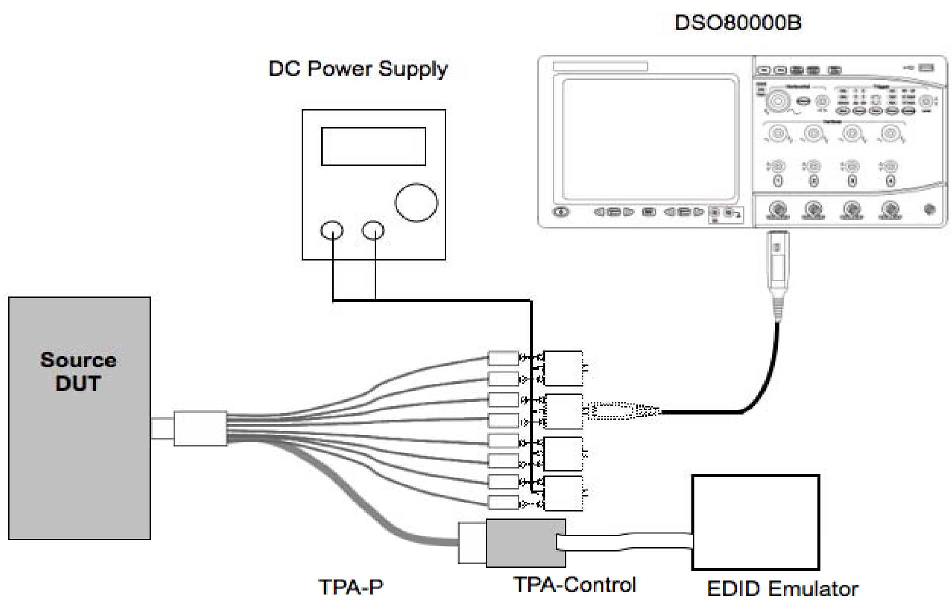


Setup 17. Test ID 7-4: TMDS – TBRISEB, TBFALLB: Tektronix DPO70804

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL / DSA70804	4.2.1.3	1
2	Differential Probe	<See reference>	4.2.1.4	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P Fixture	<See reference>	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Agilent DSO80000B



Setup 18. Test ID 7-2: TMDS –VBL: Agilent DSO80000B

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	1
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	4
4	DC Power Supply	<See reference>	4.2.1.15	1
5	EDID Emulator	Any recommended EDID emulator	4.2.3.2	1
6	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
7	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Connect the SMA differential probe head (N5380A) with the differential probe amplifier (1169A) to tested TMDS pair.
3) Connect 50 ohm termination to remaining TMDS Clock and Data pairs with 3.3V pullup. This can be done with additional differential probe heads. Alternatively, all 4 TMDS pairs may be connected to the oscilloscope simultaneously using four terminated differential probe heads.
4) Connect Power supply (3.3V) to all SMA differential probe heads.

Perform the Required Test Method with this setup. Agilent automation software may be used to automate the test sequence.

Test ID 7-5: Reserved

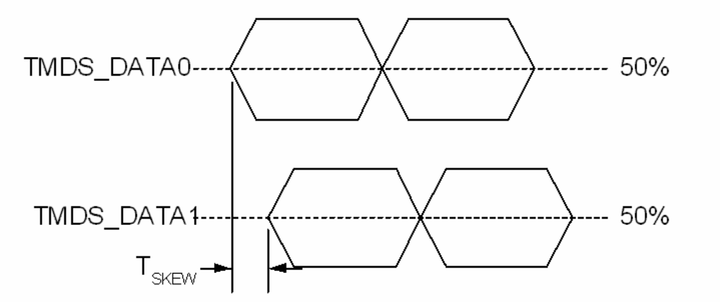
Test ID 7-6: TMDS – Inter-Pair Skew

Reference	Requirement
[HDMI: Table 4-16] Source AC Characteristics at TP1	Inter-pair skew must not exceed $0.20*T_{PIXEL}$.

Test Objective

Confirm that any skew between the differential pairs in the TMDS portion of the HDMI link does not exceed the limits in the specification.

Required Test Method



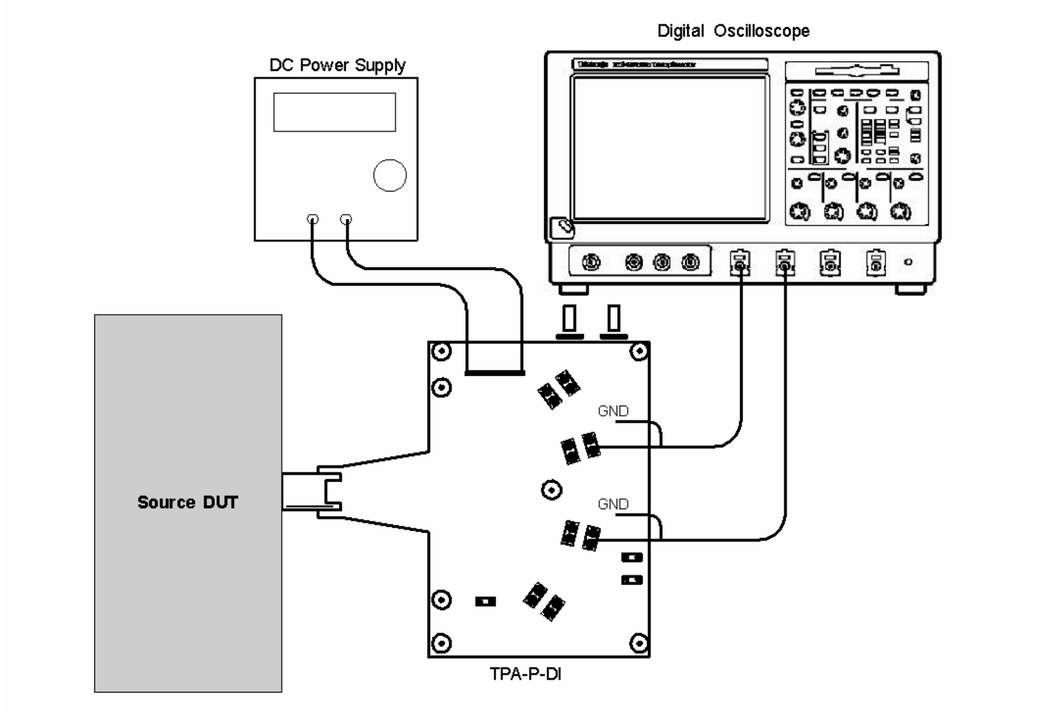
1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Connect first differential probe to TMDS_DATA0.
3) Connect second differential probe to TMDS_DATA1.
4) Configure Source DUT to output an HDMI signal with a video format and pixel size with highest supported TMDS clock frequency.
5) Capture (trigger) or find a sequence of Control Period encoded characters. Either 10-bit or 20-bit trigger may be used. For 10-bit trigger:
    6) Find the first bit of the TMDS character on the two TMDS channels. The CTL encoding pattern 1101010100 corresponds to:
    - TMDS_DATA0: HSYNC=1, VSYNC=0
    - TMDS_DATA1: CTL0=1, CTL1=0 (any Preamble)
    - TMDS_DATA2: CTL2=1, CTL3=0 (Data Island Preamble)
    - If it is difficult to capture using the above pattern, then any of the following (Control Period) patterns may be used:
        - 0010101011
        - 1101010100
        - 0010101010
        - 1101010101
    7) Examine second channel for any valid CTL code and measure T_{IPSKEW} between channels.
8) For 20-bit trigger:
    - 9) Find the first bit of the following 20-bit sequence on the TMDS channels.
        - For Channel 0: 0010101011 0011001101
        - For Channel 0: 1101010100 0011001101
        - For Channel 0: 0010101010 0011001101
        - For Channel 0: 1101010101 0011001101
        - For Channel 1: 0010101010 1100110010
        - For Channel 2: 0010101011 0011001101
    10) Examine second channel for the appropriate sequence and measure T_{IPSKEW} between channels.

11) If $T_{SKEW} > 0.2*T_{CHARACTER}$ then fail.

12) Repeat the test for remaining combinations of TMDS_DATAx pairs.

Recommended Test Method – Tektronix TDS7404

The following may only be used for testing of DUTs with a max supported TMDS clock frequency of 148.5MHz or less. For testing at 148.5MHz, it is better to use the alternative scopes below.

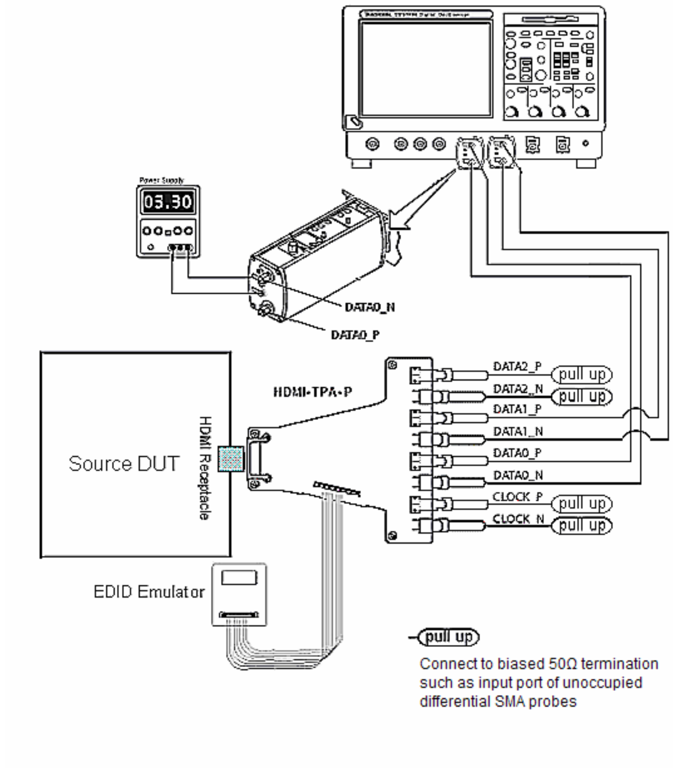


Setup 19. Test ID 7-6: TMDS – Inter-Pair Skew – Tektronix TDS7404

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Differential Probe	Tektronix P7330 or Tektronix 7350SMA	4.2.1.4	2
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P Fixture	Tektronix TPA-P-DI or TPA-P-TDR or EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Tektronix DPO70804

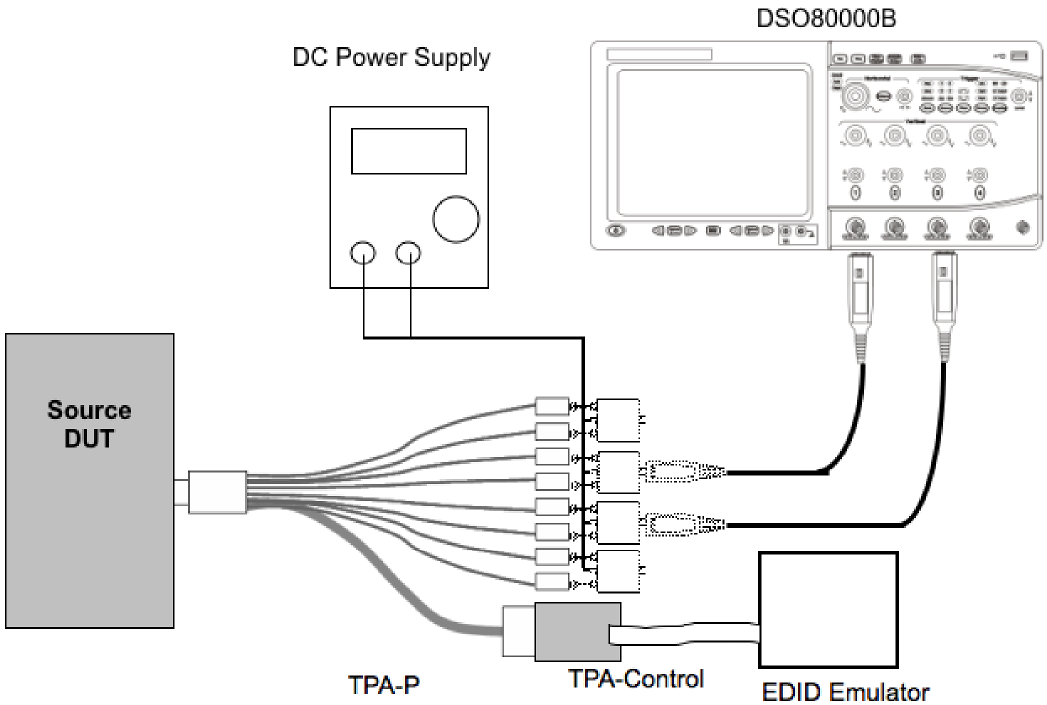


Setup 20. Test ID 7-6: TMDS – Inter-Pair Skew - Tektronix DPO70804

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL / DSA70804	4.2.1.3	1
2	Differential Probe	Tektronix P7313SMA	4.2.1.4	2
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-SMA Fixture	EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Setup - Agilent Test ID 7-6: TMDS – Inter-Pair Skew



Setup 21. Test ID 7-6: TMDS – Inter-Pair Skew – Agilent DSO80000B

No.	Description	Recommended TE	Reference	Qty.
1	8GHz Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	2
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	4
4	DC Power Supply	<See reference>	4.2.1.15	1
5	EDID Emulator	Any recommended EDID emulator	4.2.3.2	1
6	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
7	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

Perform the Required Test Method with this setup. Agilent automation software may be used to automate the test sequence.

Test ID 7-7: TMDS – Intra-Pair Skew

Reference	Requirement
[HDMI: Table 4-16] Source AC Characteristics at TP1	Intra-pair skew between TMDS DATA pairs must not exceed $0.15*T_{BIT}$.

Test Objective

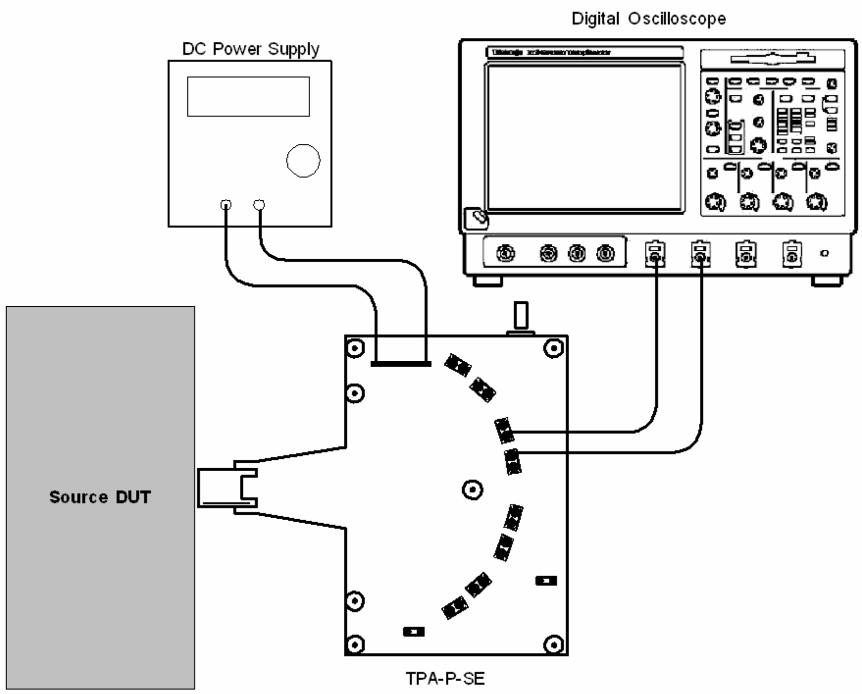
Confirm that any skew within any one differential pair in the TMDS portion of the HDMI link does not exceed the limits in the specification.

Required Test Method

1) Connect TPA-P adapter to the Source DUT HDMI output connector.
2) Connect first single-ended probe to TMDS_DATA0+.
3) Connect second single-ended probe to TMDS_DATA0-.
4) Configure Source DUT to output a video format and pixel size with highest supported TMDS clock frequency.
5) Set the trigger on TMDS_DATA0+ rising edge.
6) Display the waveform of TMDS_DATA0+ and DATA0-. Accumulate 10,000 or more triggers. Find the closest falling edge of DATA0- (either preceding or following DATA0+ rising edge), and determine the most common 50% crossing point of that TMDS_DATA0- falling edge using a horizontal (time) Histogram method.
7) Measure skew from trigger point to most common 50% crossing point of TMDS_DATA0-.
8) If (skew > $0.15*T_{BIT}$) then FAIL.
9) Repeat the test for all remaining TMDS differential pairs.

Recommended Test Method – Tektronix TDS7404

The following may only be used for testing of DUTs with a max supported TMDS clock frequency of 148.5MHz or less. For testing at 148.5MHz, it is better to use the alternative scopes below.

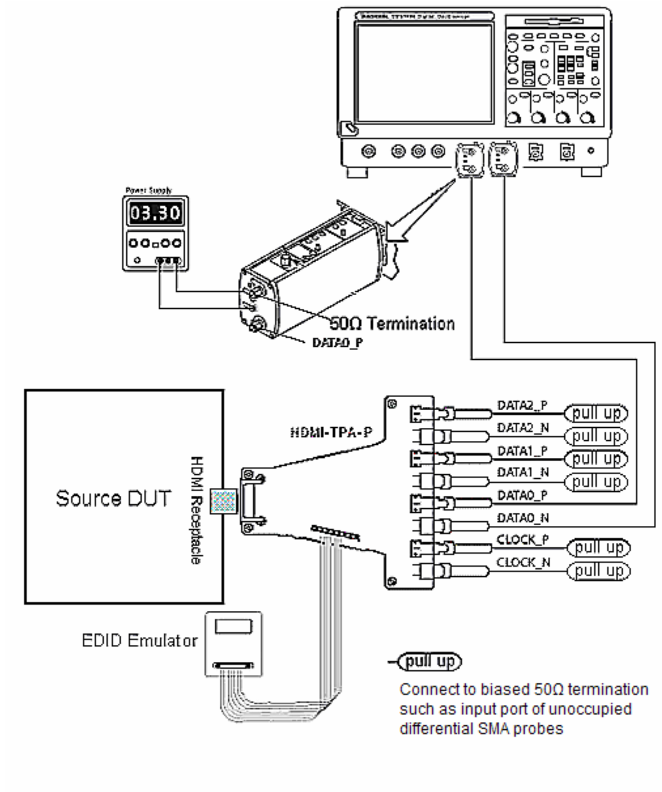


Setup 22. Test ID 7-7: TMDS – Intra-Pair Skew - Tektronix TDS7404

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Single-Ended Probes	Tektronix P7240	4.2.1.6	2
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-SE Fixture	Tektronix TPA-P-SE	4.2.1.1.4	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Tektronix DPO70804



Setup 23. Test ID 7-7: TMDS – Intra-Pair Skew - Tektronix DPO70804

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL / DSA70804 or DSA70000	4.2.1.3	1
2	Single-Ended Probes	Tektronix P7313SMA	4.2.1.6	2
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-SMA Fixture	EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.4	1

1) Connect TPA-P adapter to Source DUT HDMI output connector.

2) Configure the P7313SMA probe to perform a single-ended measurement:

    3) Connect the + side of the P7313SMA probe to the measured signal, through a 50 ohm termination to 3.3V.

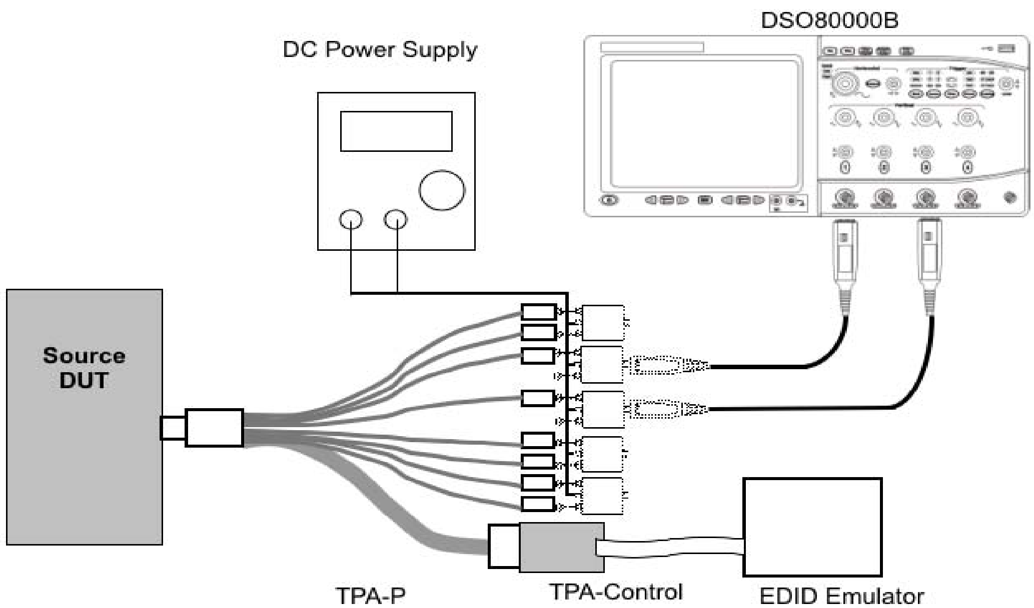
    4) Connect the – side of the probe to 3.3V through a 50 ohm termination. (This will offset the measurement to AVcc /2.)

5) If performing the test manually, setup a math expression taking the resulting input and offset it by ½ Vterm. Refer to Tektronix documentation for more info. The test automation software normally will perform this operation.

6) Connect 50 ohm termination to remaining TMDS Clock and Data signals with 3.3V pullup. This can be done with additional probes.

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Setup - Agilent Test ID 7-7: TMDS – Intra-Pair Skew



Setup 24. Test ID 7-7: TMDS – Intra-Pair Skew - Agilent

No.	Description	Recommended TE	Reference	Qty.
1	8GHz Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	2
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	5
4	DC Power Supply	<See reference>	4.2.1.15	1
5	EDID Emulator	Any recommended TE	4.2.3.2	1
6	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
7	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Connect TPA-P adapter to the Source DUT HDMI output connector.

2) Connect the + side of First SMA differential probe head (N5380A) with the differential probe amplifier (1169A) to TMDS_DATA0+. The - side of this SMA differential probe head is open.

3) Connect the + side of Second SMA differential probe head with the differential probe amplifier to TMDS_DATA0-. The - side of this SMA differential probe head is open.

4) Connect three SMA differential probe heads to remaining TMDS Clock and Data pairs for termination

5) Connect Power supply (3.3 volts) to all SMA differential probe heads.

Perform the Required Test Method with this setup. Agilent automation software may be used to automate the test sequence.

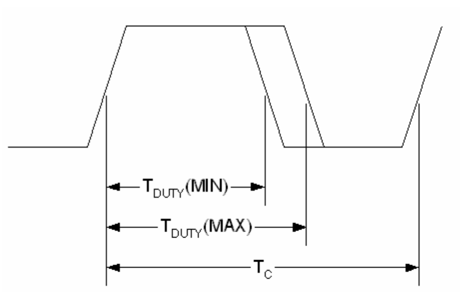
Test ID 7-8: TMDS – Clock Duty Cycle

Reference	Requirement
[HDMI: Table 4-16] Source AC Characteristics at TP1	Clock duty cycle must be at least 40% and not more than 60%.

Test Objective

Confirm that the duty cycle of the differential TMDS clock does not exceed the limits allowed by the specification.

Required Test Method



TMDS AC Clock Duty

1) Connect TPA-P adapter to Source DUT HDMI output connector.

2) Configure Source DUT to output a video format and pixel size with highest supported TMDS clock frequency.

3) Connect differential probe to TMDS Clock.

4) Display the waveform of 1 clock period.

5) Configure the Digital Oscilloscope: trigger source is the TMDS Clock rising edge, turn on infinite persistence, measurement is duty cycle, capture at least 10,000 or more triggers.

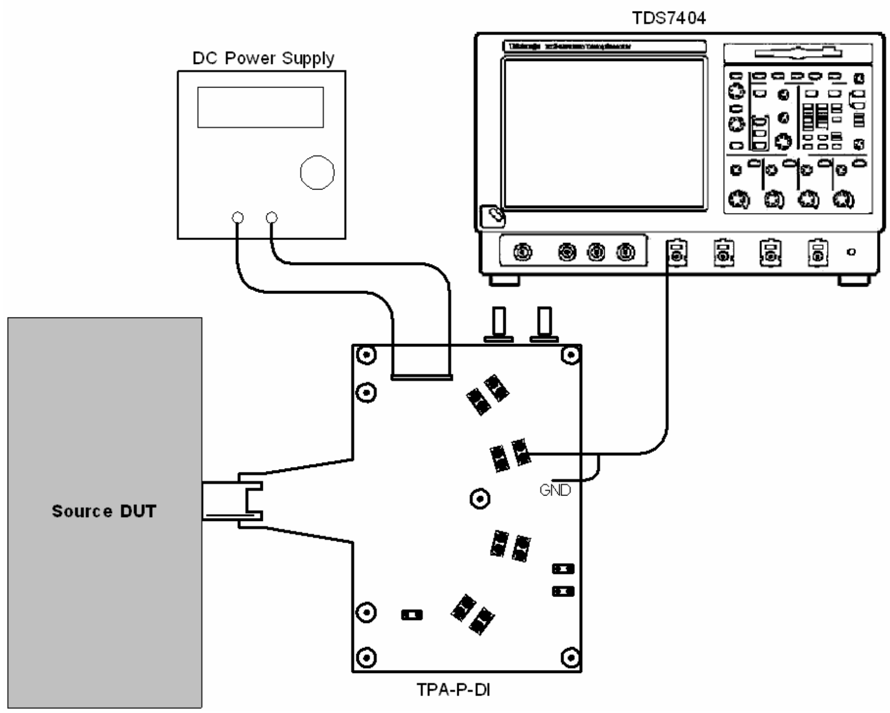
6) Measure minimum duty cycle as earliest crossing of TMDS_CLOCK falling edge.

7) Measure maximum duty cycle as latest crossing of TMDS_CLOCK falling edge.

8) If (T_{DUTY}(MIN) < 40%) OR (T_{DUTY}(MAX) > 60%) then FAIL.

Recommended Test Method – Tektronix TDS7404

The following may only be used for testing of DUTs with a max supported TMDS clock frequency of 148.5MHz or less. For testing at 148.5MHz, it is better to use the alternative scopes below.

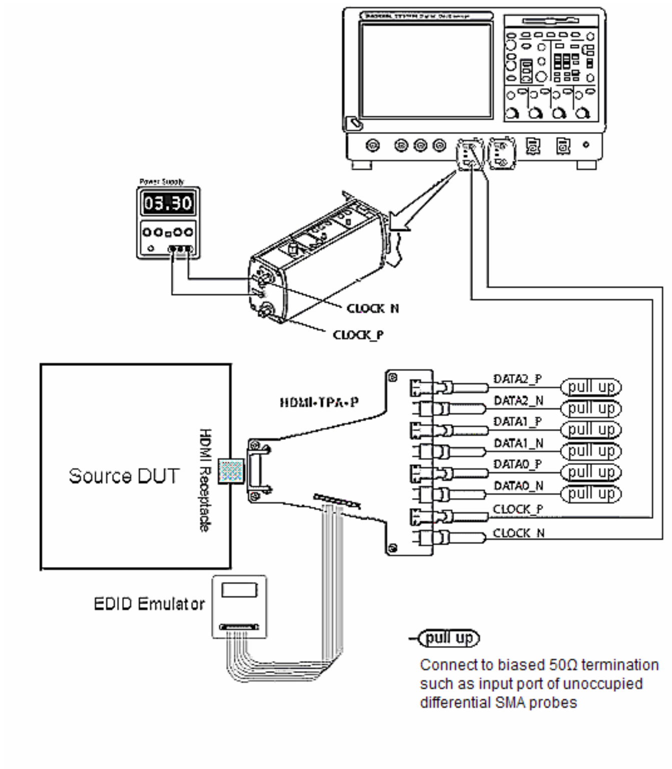


Setup 25. Test ID 7-8: TMDS – Clock Duty Cycle - Tektronix TDS7404

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Differential Probe	Tektronix P7330 or Tektronix 7350SMA	4.2.1.4	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P Fixture	Tektronix TPA-P-DI or TPA-P-TDR, or EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Tektronix DPO70804

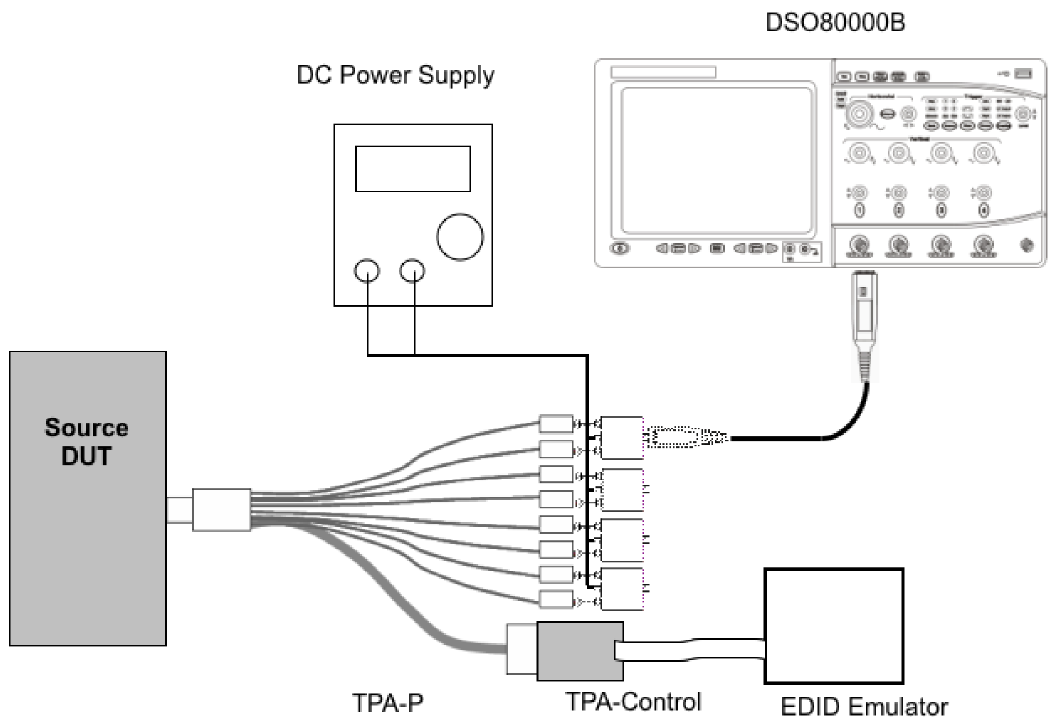


Setup 26. Test ID 7-8: TMDS – Clock Duty Cycle - Tektronix DPO70804

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL / DSA70804	4.2.1.3	1
2	Differential Probe	Tektronix P7313SMA	4.2.1.4	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-SMA	EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Setup – Agilent Test ID 7-8: TMDS – Clock Duty Cycle



Setup 27. Test ID 7-8: TMDS – Clock Duty Cycle - Agilent

No.	Description	Recommended TE	Reference	Qty.
1	8GHz Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	1
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	4
4	DC Power Supply	<See reference>	4.2.1.15	1
5	EDID Emulator	Any recommended EDID emulator	4.2.3.2	1
6	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
7	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Connect the SMA differential probe head (N5380A) with differential probe amplifier (1169A) to TMDS Clock.
3) Connect three SMA differential probe heads to three TMDS Data pairs for termination
4) Connect Power supply (3.3 volts) to all SMA differential probe heads

Perform the Required Test Method with this setup. Agilent automation software may be used to automate the test sequence.

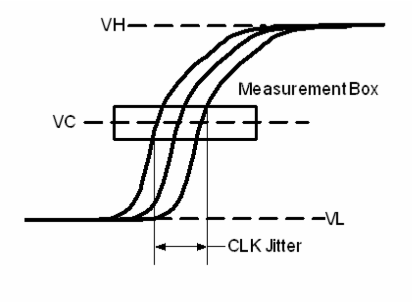
Test ID 7-9: TMDS – Clock Jitter

Reference	Requirement
[HDMI: Table 4-16] Source AC Characteristics at TP1	TMDS differential clock jitter must not exceed $0.25*T_{BIT}$, relative to the ideal Recovery Clock.

Test Objective

Confirm that the TMDS Clock does not carry excessive jitter.

Required Test Method

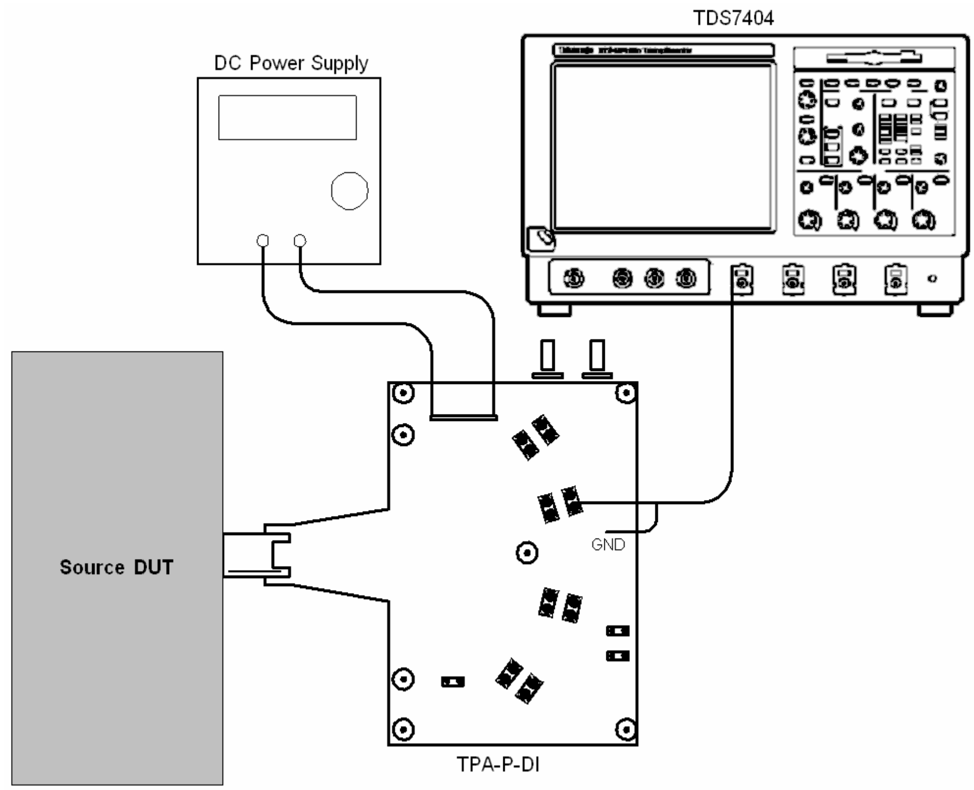


TMDS AC Clock Jitter

1) Connect TPA-P adapter to the Source DUT HDMI output connector.
2) Connect differential probe to TMDS Clock pair.
3) Configure oscilloscope and CRU:
   - Evaluate 16M samples per channel (can be acquired with a single or with multiple smaller captures).
4) Configure Source DUT to output one video format for each of the following TMDS Clock frequencies if that frequency is supported by the DUT: 27MHz (or 25MHz), 74.25MHz, 148.5MHz, and 222.75MHz. For each of these test frequencies, perform the following
   - Capture the waveform and process it with the Digital Oscilloscope
     - If test frequency is <=165MHz then set Sampling Rate ≥10GSa/s
     - If test frequency is >165MHz then set Sampling Rate ≥20GSa/s
   - Measure Clock jitter as difference between farthest left sampling point and farthest right sampling point, within the measurement box below:
     - Vertical setting = V_C = 0V ± 20mV.
   - If Clock jitter exceeds $0.25*T_{BIT}$ then FAIL
5) Repeat the test for remaining supported test frequencies. Only one video format/pixel-size combination is required per TMDS clock rate.

Recommended Test Method – Tektronix TDS7404

The following may only be used for testing of DUTs with a max supported TMDS clock frequency of 148.5MHz or less. For testing at 148.5MHz, it is better to use the alternative scopes below.

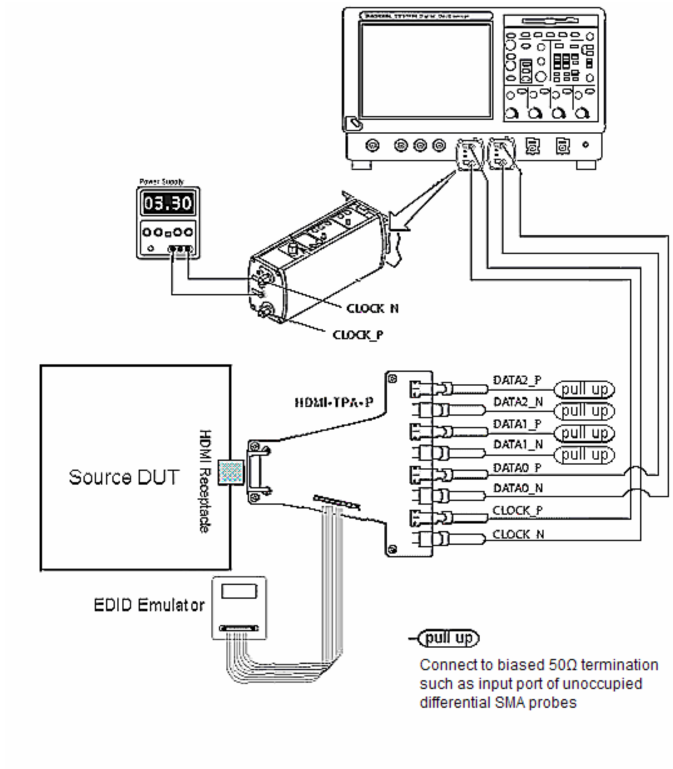


Setup 28. Test ID 7-9: TMDS – Clock Jitter - Tektronix TDS7404

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Differential Probe	Tektronix P7330 or Tektronix P7350SMA	4.2.1.4	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
5	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
6	TPA-P Fixture	Tektronix TPA-P-DI or TPA-P-TDR (as needed)	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Tektronix DPO70804

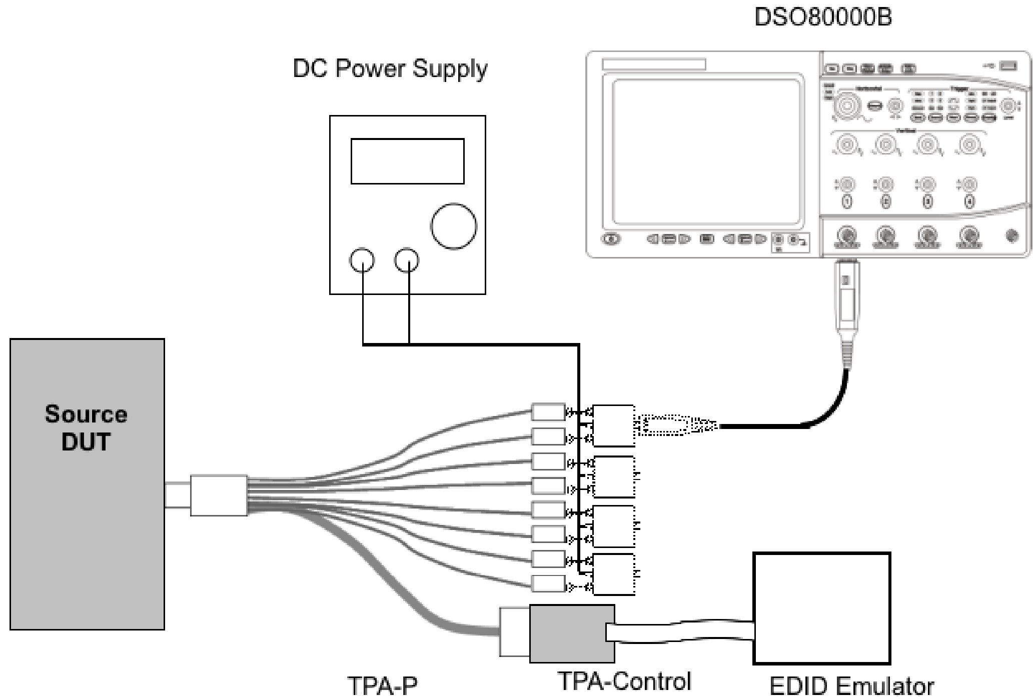


Setup 29. Test ID 7-9: TMDS – Clock Jitter - Tektronix DPO70804

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL / DSA70804	4.2.1.3	1
2	Differential Probe	Tektronix P7313SMA	4.2.1.4	1
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
5	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
6	TPA-P-SMA Fixture	EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.2	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Setup - Agilent Test ID 7-9: TMDS – Clock Jitter



Setup 30. Test ID 7-9: TMDS – Clock Jitter - Agilent

No.	Description	Recommended TE	Reference	Qty.
1	8GHz Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	1
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	4
4	DC Power Supply	<See reference>	4.2.1.15	1
5	EDID Emulator	Any recommended EDID emulator	4.2.3.2	1
6	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
7	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Connect TPA-P adapter to the Source DUT HDMI output connector.
2) Connect the SMA differential probe head (N5380A) with differential probe amplifier (1169A) to TMDS Clock.
3) Connect three SMA differential probe heads to three TMDS Data pairs for termination
4) Configure oscilloscope :
   - Single-shot trigger by rising edge of TMDS clock
   - Accumulation mode on
   - Memory length set to 16M samples per-channel with 1M/2M acquisitions.
   - If test frequency is <=165MHz then set Sampling Rate ≥10GSa/s

- If test frequency is >165MHz then set Sampling Rate ≥20GSa/s

5) Configure Software CRU:

- Software CRU input is TMDS clock
- Software CRU is the first order
- Drawing window size: horizontal is ±1.0 T_{PIXEL}

Perform the Required Test Method with this setup. Agilent automation software may be used to automate the test sequence.

Test ID 7-10: TMDS – Data Eye Diagram

Reference	Requirement
[HDMI: Figure 4-18] Eye Diagram Mask at TP1	Refer to the "Eye Diagram Mask at TP1 for Source Requirements"

Test Objective

Confirm that the differential signal on each TMDS differential data pair has an "eye opening" (region of valid data) that meets or exceeds the limits on eye opening in the specification.

Required Test Method

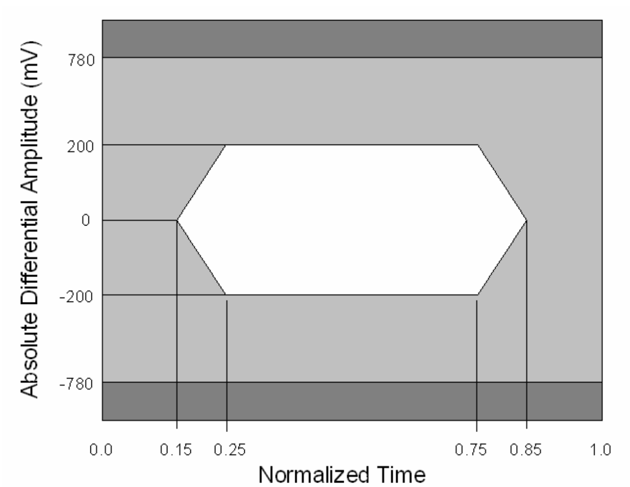


Figure 7-1 Source (TP1) Eye Diagram

1) Connect TPA-P-TDR to Source DUT HDMI output connector.
2) Connect first differential SMA probe to TMDS Clock, and configure as trigger.
3) Connect second differential SMA probe to TMDS_DATA0.
4) Connect 50 ohm pullups to each of the non-probed TMDS lines to 3.3V.

5) Configure Source DUT to output one video format for each of the following TMDS Clock frequencies if that frequency is supported by the DUT: 27MHz (or 25MHz), 74.25MHz, 148.5MHz, and 222.75MHz, and, if not already covered, the highest DUT-supported frequency. For each of these test frequencies, perform the following

   6) Capture the waveforms on the Digital Oscilloscope. Process with the CRU to display the data eye diagram.

      - Memory length set to 16M samples per-channel.
      - If test frequency is <=165MHz then set Sampling Rate ≥10GSa/s
      - If test frequency is >165MHz then set Sampling Rate ≥20GSa/s

   7) Compare the data eye to the TP1 Eye Diagram Mask:

      7.1) If any part of the waveform exceeds either the high or low maximum voltage (+/- 780mV), then FAIL.

      7.2) Shift the mask left or right through one entire T_{BIT} to determine if any horizontal position has no capture points within eye mask. No vertical shifting is allowed.

      7.3) If no shifted position exists where no part of the waveform touches or crosses into the data eye, then FAIL.

   8) Measure the data jitter at the zero crossing point.

      8.1) Measurement box vertical setting: 0V ±5mV

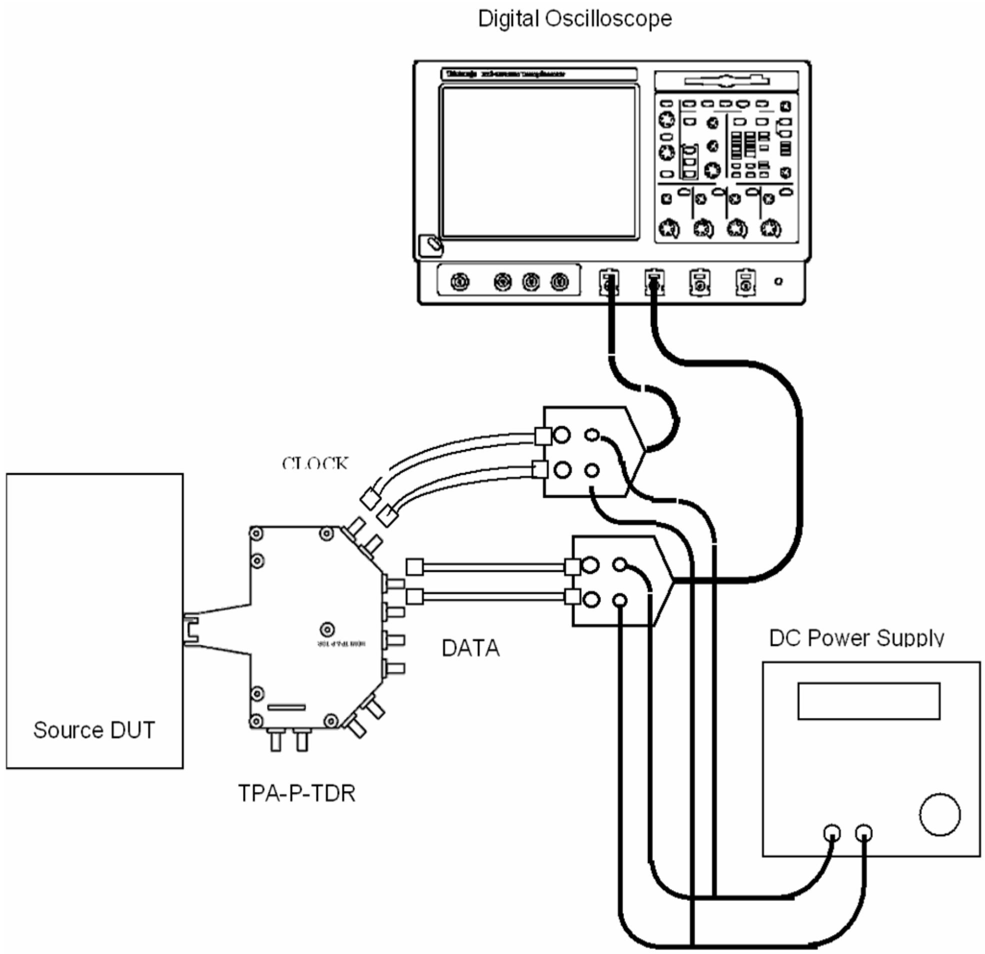
   9) If data jitter > $0.3*T_{BIT}$ then FAIL.

   10) Repeat the test for remaining TMDS_DATA pairs.

11) Repeat the test for remaining supported test frequencies. Only one video format/pixel-size combination is required per TMDS clock rate.

Recommended Test Method – Tektronix TDS7404

The following may only be used for testing of DUTs with a max supported TMDS clock frequency of 148.5MHz or less. For testing at 148.5MHz, it is better to use the alternative scopes below.

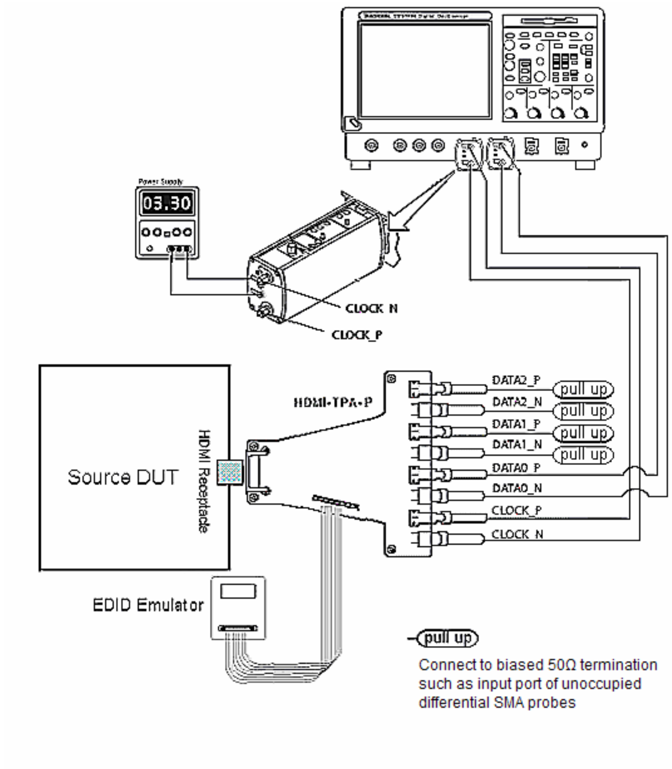


Setup 31. Test ID 7-10: TMDS – Data Eye Diagram - Tektronix TDS7404

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix TDS7404	4.2.1.3	1
2	Differential SMA Probe	Tektronix P7350SMA	4.2.1.5	2
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-TDR Fixture	<See reference>	4.2.1.1.6	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Tektronix DPO70804

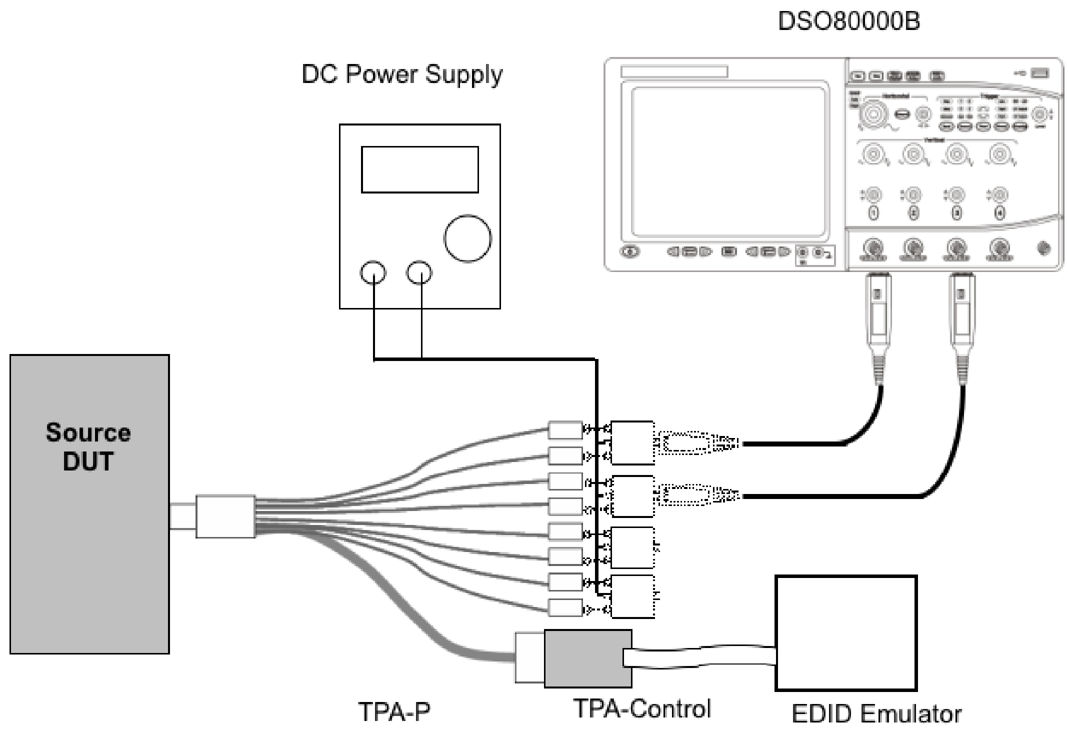


Setup 32. Test ID 7-10: TMDS – Data Eye Diagram - Tektronix DPO70804

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Tektronix DPO70804 with option 2XL / DSA70804	4.2.1.3	1
2	Differential SMA Probe	<See reference>	4.2.1.5	2
3	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P-SMA Fixture	EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.6	1

Perform the Required Test Method with this setup. Tektronix TDSHT3 software may be used to automate the test sequence.

Recommended Test Method – Agilent DSO80000B



Setup 33. Test ID 7-10: TMDS – Data Eye Diagram - Agilent

No.	Description	Recommended TE	Reference	Qty.
1	Digital Oscilloscope	Agilent DSO80000B (>=8GHz)	4.2.1.3	1
2	Differential Probe Amplifier	Agilent 1169A	4.2.1.4	2
3	SMA Differential Probe Head	Agilent N5380A	4.2.1.5	4
4	DC Power Supply	<See reference>	4.2.1.15	1
5	EDID Emulator	Any recommended EDID emulator	4.2.3.2	1
6	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
7	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Connect TPA-P to Source DUT HDMI output connector.
2) Connect first SMA differential probe head (N5380A) with differential probe amplifier (1169A) to TMDS Clock.
3) Connect second SMA differential probe head with differential probe amplifier to TMDS DATA0.
4) Connect two SMA differential probe heads to remaining TMDS Data pairs for termination
5) Connect Power supply (3.3 volts) to all SMA differential probe heads
6) Configure oscilloscope :
   - Single-shot trigger by rising edge of TMDS clock
   - Accumulation mode on

- Memory length set to 16M samples per-channel.
- If test frequency is <=74.25MHz then set Sampling Rate ≥10GSa/s
- If test frequency is >74.25MHz then set Sampling Rate ≥20GSa/s

7) Configure Software CRU:

- Software CRU input is TMDS clock
- Software CRU is the first order
- Drawing window size: horizontal is ±1.0 T_{PIXEL}

Perform the Required Test Method with this setup. Agilent automation software may be used to automate the test sequence.

Test ID 7-11: +5V Power

Reference	Requirement
[HDMI: 4.2.7] +5V Power Signal	"All Sources shall assert the +5V Power signal whenever the source is using the DDC or TMDS signals."
[HDMI: Table 4-22] Power Pin Voltage	Power pin voltage shall be 4.8V to 5.3V at TP1.

Test Objective

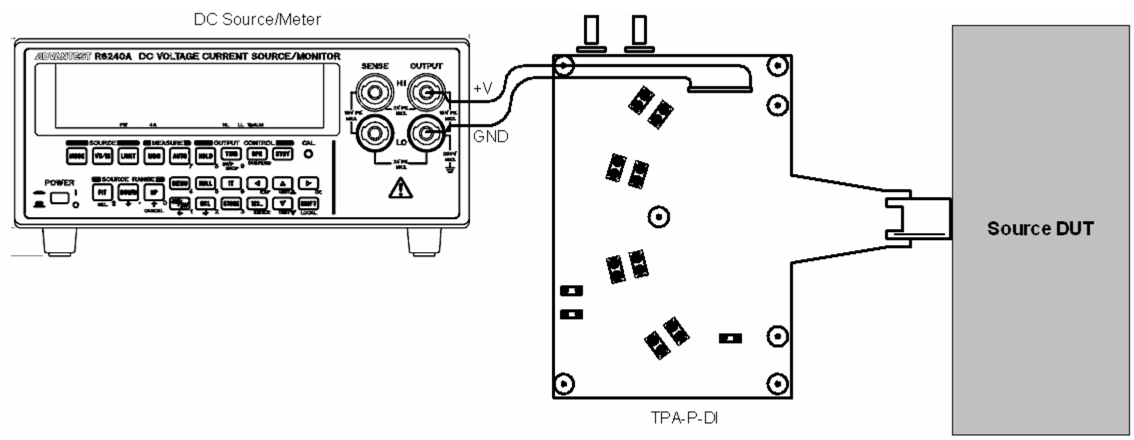
Confirm that +5V Power signal meets voltage and current capacity requirements.

Required Test Method

1) Connect TPA-P adapter to Source DUT HDMI output connector.
2) Connect the DC Source/Meter to the +5V Power signal on the TPA fixture.
3) Power on the DUT.
4) While drawing 55mA from the +5V Power pin, measure the voltage, V_{5V}.
5) If (V_{5V} < 4.8V) OR (V_{5V} > 5.3V) then FAIL
6) Repeat the test after setting up the current source to draw 0mA from the pin.

Recommended Test Method

Test ID 7-11: +5V Power



Setup 34. Test ID 7-11: +5V Power

No.	Description	Recommended TE	Reference	Qty.
1	DC Source/Meter	ADVANTEST R6240A	4.2.1.12	1
2	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
3	TPA-P	Any TPA giving access to control signals	4.2.1.1	1

Perform the Required Test Method using the Recommended Test Equipment (ISVM-type DC Source/Meter) shown above.

Test ID 7-12: Hot Plug Detect

Reference	Requirement
[HDMI: Table 4-25] Required Output Characteristics of Hot Plug Detect Signal	High voltage level (Sink) Minimum 2.4 Volts, Maximum 5.3 Volts Low voltage level (Sink) Minimum 0 Volts, Maximum 0.4 Volts Output resistance 1000Ω ±20%
[HDMI: Table 4-26] Required Detect Levels for Hot Plug Detect Signal	The high voltage level must be within 2.0V to 5.3V. The low voltage level must be within 0.0V to 0.8V.

Test Objective

Confirm that the Source load on the Hot Plug pin allows the signal to meet the specified requirements.

Required Test Method

1) Connect power supply (+) to HPD through a 1.2kΩ resistor and (–) to ground.

2) Terminate each TMDS pin to 3.3V through a 50 ohm resistor.

3) For each of the following tests, measure the voltage, V_{HPD}, at the input point of the Source's HPD pin.

4) Apply DC power of 2.4V and 5.3V. For each:

   5) Measure the voltage level at the HPD input: V_{HPD}(HIGH).

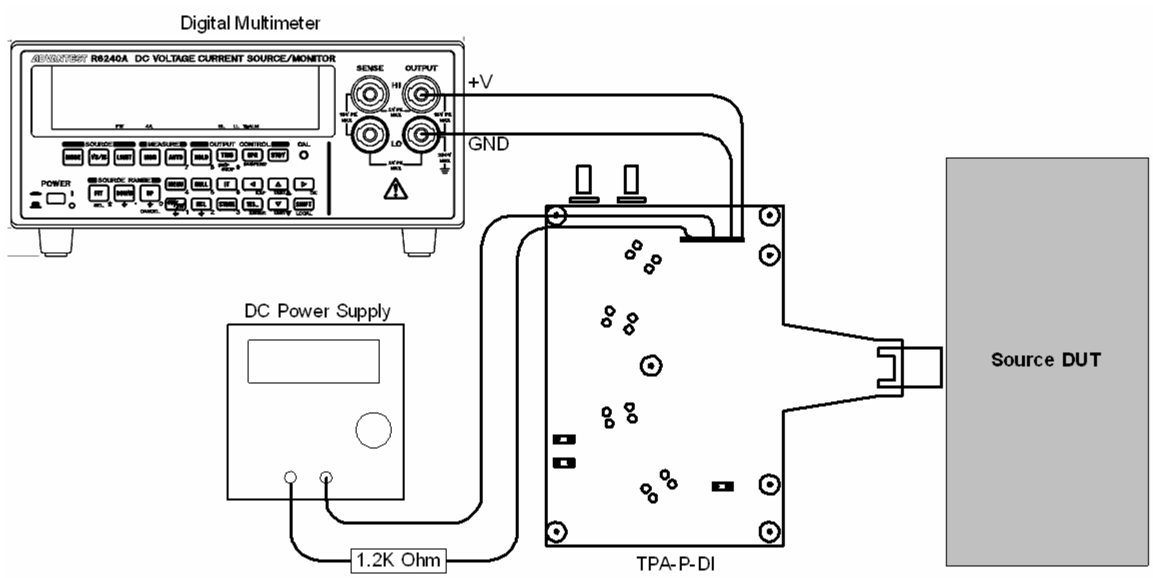
   6) If (V_{HPD}(HIGH) < 2.0V) OR (V_{HPD}(HIGH) > 5.3V) then FAIL.

7) Apply DC power of 0.0V and 0.4V. For each:

   8) Measure the voltage level at the HPD input: V_{HPD}(LOW).

   9) If (V_{HPD}(LOW) < 0.0V) OR (V_{HPD}(LOW) > 0.80V) then FAIL.

Recommended Test Method — Test ID 7-12: Hot Plug Detect



Setup 35. Test ID 7-12: Hot Plug Detect

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	DC Power Supply	<See reference>	4.2.1.15	1
3	1.2kΩ ± 1% resistor	<Any>		1
4	EDID Emulator	Any Recommended EDID Emulator	4.2.3.2	1
5	TPA-P	Any TPA giving access to DDC & CEC signals	4.2.1.1	1

Perform the Required Test Method using the Recommended Test Equipment shown above.

Termination of TMDS signals can be accomplished with TPA-P-DI.

Test ID 7-13: DDC/CEC Capacitance and Voltage

Reference	Requirement
[HDMI: 4.2.8] DDC	"The Display Data Channel (DDC) I/Os and wires … shall meet the requirements specified in the I^2C Specification, version 2.1, Section 15 for 'Standard Mode' devices." (Note: The VESA E-DDC specification specifies use of I^2C at +5V.)
[HDMI: Table 4-23] Maximum Capacitance of DDC Line	SDA capacitance must be ≤ 50pF. SCL capacitance must be ≤ 50pF.
[HDMI: Table 4-27] CEC line Electrical Specifications for all Configurations	Maximum capacitance load of a device (excluding cable) 150pF CEC Line Capacitance

Test Objective

Confirm that the capacitance load on the DDC and CEC lines does not exceed the limit in the specification and that DDC and CEC pull-ups are the correct voltage.

Required Test Method

NOTE for Repeater DUTs: This test only needs to be performed once per connector. If test has already been performed on this port, then SKIP.

- ❑ If CDF field Source_DDC_cap_power-on = "Y"
  - Turn on power to the DUT.
- ❑ else
  - Turn off power to the DUT.
- ❑ Set the LCR meter test signal:
  - DC Bias voltage = 2.5V
  - AC voltage = 3.5V peak-to-peak
  - Frequency = 100kHz
- ❑ Verify that the test equipment, including fixtures, is disconnected from the DUT.
- ❑ Connect the HPD signal to the DDC/CEC Ground signal on the TPA.
- ❑ Connect the DDC/CEC Ground signal to the frame ground of the TPA.
- ❑ Measure the capacitance of the SDA line. This is the inherent test equipment capacitance, C1.
- ❑ Attach the test equipment to the DUT and measure the capacitance of the SDA line. This is the total capacitance, C2.
- ❑ DUT capacitance, C_{DUT} = C2 – C1.
- ❑ If C_{DUT} > 50pF, then FAIL.

- Repeat the C1 and C2 measurements and the C_{DUT} calculation for the SCL pin.
- If C_{DUT} > 50pF, then FAIL.

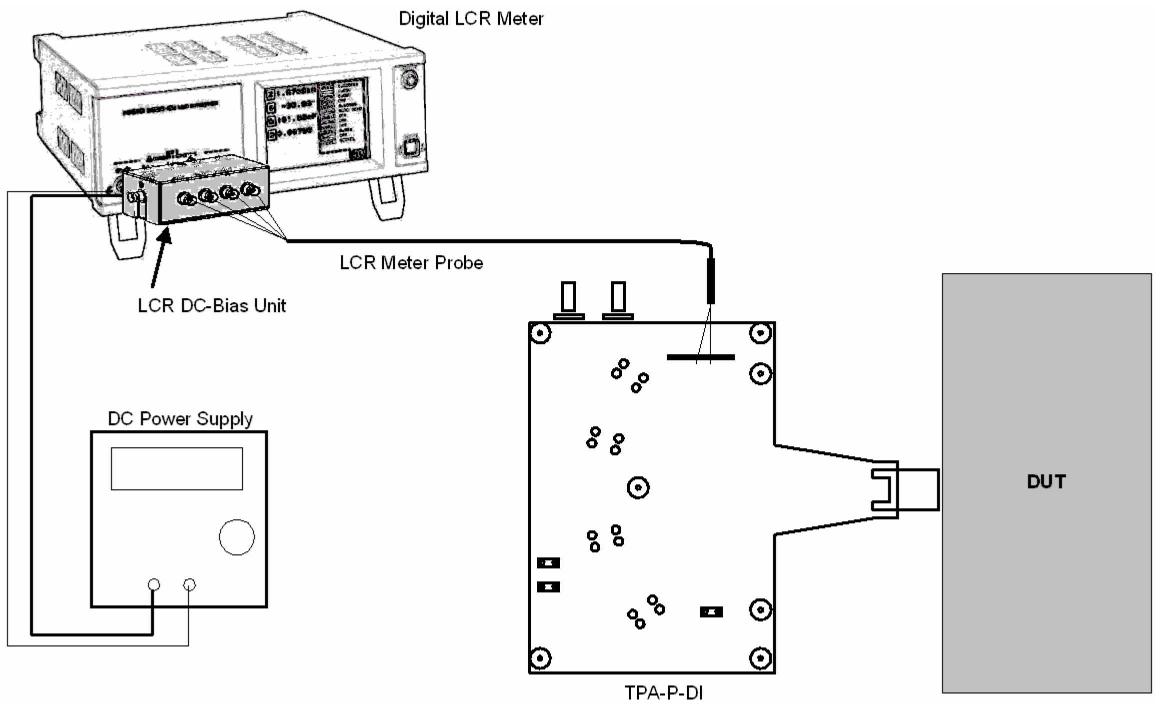
- Set the LCR meter so that the test signal delivered to the TPA has:
  - DC Bias voltage = 1.65V
  - AC voltage = 2.5V peak-to-peak
  - Frequency = 100kHz
- Disconnect the TPA from the DUT
- Perform the C1 measurement for the CEC pin on the TPA.

- Turn off power to the DUT.
- If DUT is being tested as a Repeater under Test ID 9-1, disconnect all test Source(s).
- Repeat the C2 measurement and the C_{DUT} calculation for the CEC pin.
- If C_{DUT} > 150pF, then FAIL.
- Turn on power to the DUT.
- Repeat the C2 measurement and the C_{DUT} calculation for the CEC pin.
- If C_{DUT} > 150pF, then FAIL.

- Disconnect the LCR meter from the TPA.
- Verify that the HPD signal is connected to the DDC/CEC Ground signal on the TPA.
- Turn on power to the DUT.
- Attach an oscilloscope to the DUT and measure the voltage (V_{SDA}) of the SDA line when not being driven low.
- If V_{SDA} < 4.5V or V_{SDA} > 5.5V then FAIL
- Measure the voltage (V_{SCL}) of the SCL line when not being driven low.
- If V_{SCL} < 4.5V or V_{SCL} > 5.5V then FAIL
- Measure the voltage (V_{CEC}) of the CEC line when not being driven low.
- If V_{CEC} > 0.6V and (V_{CEC} < 2.5V or V_{CEC} > 3.6V) then FAIL

- If DUT is being tested as a Repeater, reconnect test Source(s) before proceeding.

Recommended Test Method



Setup 36. Test ID 7-13: DDC/CEC Capacitance and Voltage

No.	Description	Recommended TE	Reference	Qty.
1	Digital LCR Meter	HIOKI 3522-50	4.2.1.16	1
2	LCR Meter Probe	HIOKI 9143	4.2.1.16	1
3	LCR DC-Bias Unit	HIOKI 9268-01	4.2.1.16	1
4	TPA-P	Any TPA giving access to DDC & CEC signals	4.2.1.1	1
5	General Oscilloscope	<Any>	4.2.3.4	1

1) Verify that the TPA is disconnected from the DUT.

2) Connect the Hioki DC-Bias Unit in an inverted configuration:

    2.1) Supply the DC bias voltage in the direction opposite from a typical configuration.

    2.2) As shown in setup above, probe polarity should also be connected in an inverted direction (i.e. GND line is connected to H port of the probe, and Signal line to L port). Note that, for accurate measurement, the earth line (3rd pin) of the AC plug should be disconnected for both the HIOKI-3522-50 and DC-power supply.

3) If CDF field Source_DDC_cap_power-on = "Y"

    4) Turn on power to the DUT.

else

    5) Turn off power to the DUT.

6) Connect the HPD signal to the DDC/CEC Ground signal on the TPA.

7) Connect the DDC/CEC Ground signal to the frame ground of the TPA.

8) Verify that the TPA is disconnected from the DUT.

9) Starting with a Hioki CV setting of 1.2V, adjust the CV setting until the test signal delivered to the TPA has:

   9.1) DC Bias voltage = 2.5V

   9.2) AC voltage = 3.5V peak-to-peak

   9.3) Frequency = 100kHz

10) Measure the capacitance of the SDA line. This is the inherent test equipment capacitance, $C1_{SDA}$.

11) Measure the capacitance of the SCL line: $C1_{SCL}$.

12) Attach the TPA to the DUT.

13) Measure the capacitance of the SDA line. This is the total capacitance, $C2_{SDA}$.

14) Calculate the DUT capacitance, $C_{DUT\_SDA} = C2_{SDA} – C1_{SDA}$.

15) If C_{DUT_SDA} > 50pF, then FAIL.

16) Disconnect the TPA from the DUT

17) Measure the inherent TE capacitance of the SCL line, $C1_{SCL}$.

18) Attach the TPA to the DUT.

19) Measure the total capacitance of the SCL line, $C2_{SCL}$.

20) $C_{DUT\_SCL} = C2_{SCL} – C1_{SCL}$.

21) If C_{DUT_SCL} > 50pF, then FAIL.

22) Disconnect the TPA from the DUT

23) Starting with a CV value of 0.9V, adjust the LCR meter CV setting until the test signal delivered to the TPA has:

   - DC Bias voltage = 1.65V
   - AC voltage = 2.5V peak-to-peak
   - Frequency = 100kHz

24) Measure the capacitance of the CEC pin to measure the intrinsic capacitance of the TPA, $C1_{CEC}$.

25) Turn off power to the DUT

26) If DUT is being tested as a Repeater under Test ID 9-1, disconnect all test Sources.

27) Connect the TPA to the DUT.

28) Measure the total capacitance of the CEC line, $C2_{OFF\_CEC}$.

29) $C_{DUT\_OFF\_CEC} = C2_{OFF\_CEC} – C1_{CEC}$.

30) If $C_{DUT\_OFF\_CEC}$ > 150pF, then FAIL.

31) Turn on power to the DUT.
32) Repeat the C2 measurement and the $C_{DUT\_ON\_CEC}$ calculation for the CEC pin.
33) If $C_{DUT\_ON\_CEC}$ > 150pF, then FAIL.

34) Disconnect the LCR meter from the TPA, leaving the TPA connected to the DUT.
35) Verify that the HPD signal is connected to the DDC/CEC Ground signal on the TPA.
36) Turn on power to the DUT.
37) Attach the oscilloscope to the DUT and measure the voltage (V_{SDA}) of the SDA line when it is not being driven low.
38) If V_{SDA} < 4.5V or V_{SDA} > 5.5V then FAIL
39) Measure the voltage (V_{SCL}) of the SCL line when not being driven low.
40) If V_{SCL} < 4.5V or V_{SCL} > 5.5V then FAIL
41) Measure the voltage (V_{CEC}) of the CEC line when not being driven low.
42) If V_{CEC} > 0.6V and (V_{CEC} < 2.5V or V_{CEC} > 3.6V) then FAIL

43) If DUT is being tested as a Repeater, reconnect test Sources before proceeding.

Test ID 7-14: CEC Line Connectivity

Reference	Requirement
[HDMI: Table 4-27] CEC Line Connectivity	<See reference for details>

Test Objective

Ensure that CEC lines on all inputs and outputs are connected as specified in following description:

CEC lines from all HDMI inputs (if present) and a single HDMI output (if present) shall be interconnected.

Except :

- A device which has no HDMI output is allowed to have separate CEC lines for each HDMI connector if that device takes a logical address of 0 on each CEC line.
- A device that is acting as the CEC root device shall not connect the CEC line to any HDMI output.

Required Test Method

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document. If test has already been performed on product, then SKIP.

[Verify correct CDF fields: Independent CEC may be set only if DUT has no HDMI output and only if DUT is performing CEC operations at logical address 0]

- ❑ If CDF field Independent_CEC = “Y” then:
    - If CDF field HDMI_output_count > 0 then FAIL
    - If CDF field CEC_protocol = “N” then FAIL

[Verify that CEC pins on all input connectors are tied together]

- ❑ Turn DUT off
- ❑ For every combination of two HDMI input connectors on the DUT:
    - Measure the resistance between the CEC pins of the two connectors.
    - If any resistance measurement > 5Ω then:
        - If CDF field Independent_CEC = “N” then FAIL
        - If resistance < 48kΩ then FAIL

[Verify that DUT has CEC connected to only 1 output]

- ❑ For every output connector;
    - Measure the resistance between the CEC pin of that output connector and the CEC pin of each input connector.
    - If resistance is between 5Ω and 1MΩ then FAIL
    - If resistance is less than 5Ω then note the output connection ID.
- ❑ If more than one output connection ID noted then FAIL
- ❑ If no output connection ID noted,
    - If CDF field CEC_root_device = “N” then FAIL

Recommended Test Method

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	TPA-P	Any TPA giving access to CEC signals	4.2.1.1	2

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document. If test has already been performed on product then SKIP.

Note that two TPA-P boards may be needed to perform this test and, due to the mechanical constraints of the product, it may be impossible to insert more than one TPA-P board into the DUT simultaneously. It is permitted to use a short HDMI cable in connection with a TPA-R board in place of one or both of the TPA-P boards. To calibrate, measure the resistance of the CEC wires in each short cable, add those values to determine the total CEC test equipment resistance and subtract that value from the test measurements below before performing the test comparisons below.

[Verify correct CDF fields]

If CDF field Independent_CEC = “Y” then:

- If CDF field HDMI_output_count > 0 then FAIL
- If CDF field CEC_protocol = “N” then FAIL

[Verify that CEC pins on all input connectors are tied together]

1) Turn DUT off
2) Set Digital Multi-Meter to measure resistance using auto scale mode.
3) Connect one probe of the meter to the CEC pin on the first TPA-P
4) Connect the other probe of the meter to the CEC pin on the second TPA-P
5) For every combination of two HDMI input connectors on the DUT
    6) Connect first TPA-P to first selected HDMI connector
    7) Connect second TPA-P to second selected HDMI connector
    8) Read resistance value from Digital Multi-Meter
    9) If reading is greater than 5Ω then:
        10) If CDF field Independent_CEC = “N” then FAIL
        11) If resistance < 48kΩ then FAIL

[Verify that DUT has CEC connected to at most 1 output]

12) For every HDMI output connector (from 1 to value in CDF field HDMI_output_count):
    13) Connect first TPA-P to selected HDMI output connector
    14) For every HDMI input connector:
        15) Connect second TPA-P to selected HDMI input connector
        16) Read resistance value from Digital Multi-Meter
        17) If resistance is between 5Ω and 1MΩ then FAIL
        18) If resistance is less than 5Ω then note the output connection ID.
    19) Continue to next input connector
20) Continue to next output connector
21) If more than one output connection ID noted then FAIL, “CEC line connected to > 1 output”
22) If no output connection ID noted,
    23) If CDF field CEC_root_device = “N” then FAIL, “CEC line not connected to any output”

Test ID 7-15: CEC Line Degradation

Reference	Requirement
[HDMI: Table 4-27] CEC line Electrical Specifications for all Configurations	A device with power removed (from the CEC circuitry) shall not degrade communication between other CEC devices (e.g. the line shall not be pulled down by the powered off device). Maximum CEC line leakage current must be ≤1.8μA

Test Objective

Ensure that the DUT does not degrade communication between other CEC devices when power is applied, when power is removed and, if supported, in standby mode (the line must not be pulled down by the powered off device).

Required Test Method

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document.

- ❑ If DUT is being tested as a Repeater under Test ID 9-1, disconnect all test Source(s) and Sink(s).
- ❑ If CDF field CEC_protocol is N then
  - Connect the CEC line on DUT to DDC/CEC Ground via a 1MΩ ±5% resistor
  - Power on DUT

    [Measure voltage when “disconnected”]
    - Measure CEC line voltage on DUT and record as V_{CEC1}.
    - If V_{CEC1} is in the range 0V to 0.1V [no connect] or is in the range > 2.88V to 3.63V then continue else then FAIL
  - Disconnect the CEC line from DDC/CEC Ground

    [Measure voltage when “pulled-up externally”]
  - Connect the CEC line to 3.3V via a 27kΩ ±5% resistor
    - Measure CEC line voltage.
    - If voltage not 3.3V ±10% then → FAIL

    [Measure voltage when “pulled-down externally”]
  - Connect the CEC line on the DUT to DDC/CEC Ground via 1kΩ ±5% load resistor (as well as the previously connected 3.3V via 27kΩ±5%)
    - Measure CEC line voltage on the DUT output connector and record as V_{CEC2}
    - If V_{CEC1} is in the range 0V to 0.1V and V_{CEC2} is not in the range 0.12V ±12% then → FAIL
    - If V_{CEC1} is in the range 2.88V to 3.63V and V_{CEC2} is not in the range 0.196V to 0.274V then → FAIL

- Repeat tests with DUT in power off state
- If standby power mode exists on DUT, repeat test in that state

[Perform following for all DUTs whether or not they support CEC_protocol]

- ❑ Remove power (mains) from DUT
- ❑ Disconnect CEC line from both resistors going to DDC/CEC Ground and 3.3V
- ❑ Connect CEC line to 3.63V via 27kΩ ±5% resistor with ammeter in series
- ❑ Measure the CEC line leakage current. If current > 1.8μA then → FAIL

- ❑ If DUT is being tested as a Repeater, reconnect test Source(s)/Sink(s) before proceeding.

Recommended Test Method

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	DC Power Supply	<See reference>	4.2.1.14	1
3	27kΩ±5% resistor	<any>		1
4	1kΩ±5% Resistor	<any>		1
5	1MΩ±5% Resistor	<any>		1
6	TPA-P	Any TPA giving access to CEC signals	4.2.1.1	1

TPA-CEC-R incorporates the resistances shown above and so may be used instead of other TPA-P and discrete resistors.

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document.

1) If DUT is being tested as a Repeater under Test ID 9-1, disconnect all test Sources and Sink(s).
2) If CDF field CEC_protocol is N then
    3) Connect TPA to DUT
    4) Set DC Power Supply to 3.3V
    5) Connect the CEC line to DDC/CEC Ground on the TPA-P via a 1MΩ ±5% resistor
    6) Set Multi-Meter to voltage measurement and connect between CEC pin and DDC/CEC Ground on TPA
    7) Power on DUT
        8) Measure voltage with Multi-Meter, record as V_{CEC1}
        9) if (V_{CEC1} is in the range 0V to 0.1V) or (V_{CEC1} is in the range 2.88V to 3.63V) then continue else then FAIL

10) Disconnect the CEC line from DDC/CEC Ground
11) Connect the CEC line on TPA to DC Power Supply (3.3V) via the 27kΩ ±5% resistor
12) Measure voltage; if voltage is not 3.3V ±10% then → FAIL
13) Connect the CEC line on the TPA to DDC/CEC Ground on TPA via 1kΩ ±5% load resistor (as well as the previously connected 3.3V via 27kΩ)
14) Measure voltage, record as V_{CEC2}
15) If V_{CEC1} in the range 0V to 0.1V and V_{CEC2} is not in the range 0.12V ±12% then → FAIL
16) If V_{CEC1} >= 2.88V and <= 3.63V and V_{CEC2} is not in the range 0.196V to 0.274V then → FAIL

17) Repeat tests with DUT in power off state
18) If standby power mode exists on DUT, repeat test in that state

[Perform following for all DUTs whether or not they support CEC_protocol]

19) Remove power (mains) from DUT
20) Disconnect CEC line from both resistors going to DDC/CEC Ground and 3.3V
21) Set DC Power Supply to 3.63V
22) Connect the CEC line on the TPA input connector to one end of 27kΩ resistor
23) Set Multi-Meter to current measurement and connect between free end of 27kΩ resistor and DC power supply.
24) From multi-meter, record leakage current. If measured current > 1.8μA then → FAIL
25) If DUT is being tested as a Repeater, reconnect test Source(s)/Sink(s) before proceeding.

7.4 Source – Protocol

7.4.1 Required Test Method Setup for Protocol Tests

Unless stated otherwise, the Required Test Method for all of the tests in this section includes the following setup and Source DUT operation:

Connect Source DUT to an Encoding Analyzer or Protocol Analyzer as specified in test.

1) Operate the Source DUT to transmit any one of the following video format timings for at least 2 seconds while also transmitting 2-channel PCM audio (if supported) at the highest supported audio sampling rate:
   - 720x480p @ 59.94Hz
   - 640x480p @ 59.94Hz
   - 720x576p @ 50Hz
2) Perform the specified protocol test(s) for the entire analysis period.
3) Operate the Source DUT to transmit the first of the following video format timings which is supported by the DUT (if any are supported) while also transmitting 2-channel PCM audio (if supported) at the highest supported audio sampling rate:
   - 1080i @ 60Hz
   - 720p @ 60Hz
   - 1080i @ 50Hz
   - 720p @ 50Hz
4) Perform the specified protocol test(s) for the entire analysis period.

Note that with the most common Recommended Test Equipment, all of the Protocol tests (except for the conditional second half of Test ID 7-19) can be performed with a single capture for each of the two selected video formats from above.

7.4.2 Tests

Test ID 7-16: Legal Codes

Reference	Requirement
[HDMI: 5.1.2] Operating Modes Overview	"The HDMI link operates in one of three modes: Video Data Period, Data Island period, and Control period."
[HDMI: 5.2.2.1] Video Guard Band	<See reference for details.>
[HDMI: 5.2.3.3] Data Island Guard Band	<See reference for details.>
[HDMI: 5.4.2] Control Period Coding	<See reference for details.>
[HDMI: 5.4.3] TERC4 Coding	<See reference for details.>
[HDMI: 5.4.4] Video Data Coding	<See reference for details.>

Test Objective

Verify that Source only outputs legal 10-bit codes.

Required Test Method

Connect DUT to a recommended Encoding Analyzer and operate Source DUT as described in Section 7.4.1.

- ❑ Verify that, for all pixels within the analysis period, the Source DUT transmits only 10-bit values on each of the three TMDS channels that correspond to one of the following:
  - Any legal Video Data codes
    - Any Video Data Code that was encoded with an incorrect "data stream disparity" value, that is, which causes the channel to become more, rather than less DC-balanced.
  - 4 Control Period codes
  - 16 TERC4 codes
  - Data Island Guard Band (all 4 possible values for Channel 0)
  - Video Guard Band
- ❑ [Illegal 10-bit code] If any channel contains a 10-bit code that is not one of the above then FAIL
- ❑ Verify that, for all pixels, all three TMDS channels are encoded using the same of the 5 encodings above.
- ❑ [Inconsistent channel coding] If any $T_{CHARACTER}$ does not use consistent encoding across all three channels then FAIL

Recommended Test Method — Test ID 7-16: Legal Codes

1) Setup Source DUT and Encoding Analyzer and operate Source DUT as described in Section 7.4.1.
2) Output one of the 480p/576p formats described in Section 7.4.1.
    3) HDMI Analysis command: 'Full HDMI Compliance' or 'Legal Codes'
    4) If HDMI Analysis reports 'PASS', then PASS, else FAIL
5) Output one of the 1080i/720p formats described in Section 7.4.1.
    6) HDMI Analysis command: 'Full HDMI Compliance' or 'Legal Codes'
    7) If HDMI Analysis reports 'PASS', then PASS, else FAIL

Test ID 7-17: Basic Protocol

Reference	Requirement
[HDMI: 5.2.1] Control Period	"The HDCP-specified Enhanced Encryption Status Signaling ENC_EN code (CTL0:3=1001) shall not be used except as a correct ENC_EN during the HDCP-specified window of opportunity."
[HDMI: 5.2.1.1] Preamble	"Immediately preceding each Video Data Period or Data Island Period is the Preamble. This is a sequence of eight identical Control characters that indicate whether the upcoming data period is a Video Data Period or is a Data Island." "The Data Island Preamble control code (CTL0:3=1010) shall not be transmitted except for correct use during a Preamble period."
[HDMI: 5.2.2] Video Data Period	"…the Video Data Period begins with a two character Video Leading Guard Band."
[HDMI: 5.2.3] Data Island Period	"The first two data characters within the Data Island are the Leading Guard Band. The last two data characters within the Data Island are the Trailing Guard Band."
[HDMI: Table 5-3] TMDS Link Timing Parameters	"Minimum duration Control Period: 12 T_{PIXEL}"
[HDMI: 5.4] Encoding	<See reference for details.>

Test Objective

Verify that Source only outputs code sequences for Control Periods, Data Island Periods and Video Data Periods corresponding to basic HDMI protocol rules.

Required Test Method

Connect Source DUT to a Protocol Analyzer and operate as described in Section 7.4.1.

- ❑ Suspend HDCP functionality (if present) and examine the CTL3:CTL2:CTL1:CTL0 values for the 16 (Control-encoded) pixels during the HDCP-specified window of opportunity. If the ENC_EN code (CTL0:3=1001) is included. then FAIL, (ENC_EN code is detected)
- ❑ For every transition from a character with Control Period Coding to next character using any other (non-Control) encoding:
  - If the 12 pixels prior to the transition contain any pixels not encoded with Control Period Coding then FAIL, (Control Period too short)
  - Examine the CTL3:CTL2:CTL1:CTL0 values for the 8 (Control-encoded) pixels immediately prior to the transition and compare to the values 0b0001 (Video Data Period Preamble) and 0b0101 (Data Island Preamble).
  - [Check for Invalid Data Island Preamble control code usage]
    - Examine whole control period prior to the Preamble. If the period includes Data Island Preamble control code (CTL0:3=1010) then FAIL
  - [Inconsistent Preamble]
  - If any of the 8 pixels does not match the CTLx value for any of the other 7 pixels then FAIL
  - [Illegal Preamble]
  - If the Preamble value is neither Data Island Preamble nor Video Data Preamble then FAIL
  - If the Preamble value is Data Island Preamble:
    - Examine the first two pixels following the Preamble (Leading Guard Band).
    - If TMDS channel 0 for either of these pixels does not equal one of the 4 permitted Data Island Guard Band characters (0xC, 0xD, 0xE, 0xF) [HDMI: 5.2.3.3] then FAIL
    - If TMDS channel 1 or 2 for either of these pixels does not equal the specified Data Island Guard Band character [HDMI: 5.2.3.3] then FAIL
    - Scan through following pixels, while counting pixels, until finding a transition to Control Period Coding, verifying that every character is encoded with Data Island Coding.
    - Examine the last two pixels preceding this transition (Trailing Guard Band).
    - If TMDS channel 0 for either of these pixels does not equal one of the 4 permitted Data Island Guard Band characters (0xC, 0xD, 0xE, 0xF) [HDMI: 5.2.3.3] then FAIL
    - If TMDS channel 1 or 2 for either of these pixels does not equal the specified Data Island Guard Band character [HDMI: 5.2.3.3] then FAIL
    - If any character following the Leading Guard Band but preceding the Trailing Guard Band is not a legal TERC4 code then FAIL
    - If first character following the Leading Guard Band has TERC4 ch. 0, bit 3 == 1 then FAIL
    - If any other character prior to Trailing Guard Band has TERC4 ch. 0, bit 3 != 1 then FAIL
    - Length of Data Island is equal to number of pixels following Leading Guard Band and prior to Trailing Guard Band. Number of packets = Length of Data Island / 32.
    - If number of packets is not an integer then FAIL
    - If number of packets == 0 then FAIL

- If number of packets > 18 then FAIL
- For every packet within the Data Island:
  - For each of the 5 ECC blocks within the packet:
    - If BCH parity bits are incorrect then FAIL

- If the Preamble value is Video Data Preamble:
  - Examine the first two pixels following the Preamble.
  - If either of these pixels does not equal the Video Data Guard Band character [HDMI: 5.2.2.1] then FAIL
  - Scan through following pixels until finding a transition to Control Period Coding, verifying that every character is encoded with Video Data Coding.
  - If any character following Video Guard Band up to transition is not a correctly encoded Video Data code then FAIL

❑ If no "FAIL" above, then PASS

Recommended Test Method — Test ID 7-17: Basic Protocol

1) Setup Source DUT and Protocol Analyzer and operate Source DUT as described in Section 7.4.1.
2) Output one of the 480p/576p formats described in Section 7.4.1.
   3) HDMI Analysis command: 'Full HDMI Compliance' or 'Basic Protocol'
   4) If HDMI Analysis reports 'PASS', then PASS, else FAIL
5) Output one of the 1080i/720p formats described in Section 7.4.1.
   6) HDMI Analysis command: 'Full HDMI Compliance' or 'Basic Protocol'
   7) If HDMI Analysis reports 'PASS', then PASS, else FAIL

Test ID 7-18: Extended Control Period

Reference	Requirement
[HDMI: Table 5-4] Extended Control Period Parameters	Maximum time between Extended Control Periods 50 msec Minimum duration Extended Control Period 32 T_{PIXEL}

Test Objective

Verify that Source outputs an Extended Control Period within the required period.

Required Test Method

Connect Source DUT to a Protocol Analyzer and operate as described in Section 7.4.1.

❑ Starting with the first character of the capture, perform the following search for each 50milliseconds of capture

- [Search for Extended Control Period]

- If no Control Period within the 50msecs is 32 or more pixels in length then FAIL
- If any Control Period within the 50msecs is 32 or more pixels in length then CONTINUE

Recommended Test Method

1) Setup Source DUT and Protocol Analyzer and operate Source DUT as described in Section 7.4.1.
2) Output one of the 480p/576p formats described in Section 7.4.1.
    3) HDMI Analysis command: 'Full HDMI Compliance' or 'Extended Control Period'
    4) If HDMI Analysis reports 'PASS', then PASS, else FAIL
5) Output one of the 1080i/720p formats described in Section 7.4.1.
    6) HDMI Analysis command: 'Full HDMI Compliance' or 'Extended Control Period'
    7) If HDMI Analysis reports 'PASS', then PASS, else FAIL

Test ID 7-19: Packet Types

Reference	Requirement
[HDMI: 5.3] Data Island Packets	<See reference for details.>
[HDMI: 8.8] ISRC Handling	"When fields UPC_EAN_ISRC_16 through 31 include effective data (i.e. not "reserved"), a subsequent ISRC2 Packet shall be transmitted. In other cases, the ISRC2 packet may optionally be transmitted. " "When a subsequent ISRC2 Packet is transmitted, the ISRC_Cont field shall be set and shall be clear otherwise."
[HDMI: 9.3] Usage of Audio Content Protection (ACP) Packets	<See reference for details.>

Test Objective

Verify that Source only transmits permitted Packet Types and that reserved fields are zero.

Required Test Method

- ❑ Connect Source DUT to a Protocol Analyzer, containing an EDID with
  - HDMI VSDB length field == 6 with
    - Supports_AI bit = 1
  - No support for non-primary video formats
  - Only Basic Audio support (no compressed, DSD, DST or High-Bitrate audio formats)
  - No Colorimetry Data Block
- ❑ Operate as described in Section 7.4.1.
- ❑ If no Data Island is detected at least once per two video fields then FAIL

- For each Packet within each Data Island in the capture:
  - If packet type is not equal to any of the following: 0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x81, 0x82, 0x83, 0x84, 0x85 then FAIL, (optionally continue to next packet)
  - If packet type is equal to 0x00 (Null Packet)
    - Check bytes HB1, HB2 and all bytes in packet body.
    - If any bytes do not equal 0x00 then FAIL
  - If packet type is equal to 0x01 (ACR Packet)
    - Check bytes HB1, HB2.
    - If HB1 or HB2 does not equal 0x00 then FAIL
    - Check byte SB0 of subpacket 0
    - If SB0 does not equal 0x00 then FAIL
    - Check byte SB1 of subpacket 0
    - If bits 7, 6, 5 and 4 of SB1 do not equal 0 then FAIL
    - Check byte SB4 of subpacket 0
    - If bits 7, 6, 5 and 4 of SB4 do not equal 0 then FAIL
    - Compare SB0…SB6 of subpacket 0 with SB0…SB6 of every other subpacket. Likewise compare subpacket 1 with subpacket 2 and 3 and compare subpacket 2 with subpacket 3.
    - If any subpacket differs from any other then FAIL
  - If packet type is equal to 0x02 (Audio Sample Packet)
    - Check byte HB1.
    - If bits 7, 6, and 5 of HB1 do not equal 0 then FAIL
  - If packet type is equal to 0x03 (General Control Packet)
    - Check bytes HB1, HB2.
    - If either byte does not equal 0x00 then FAIL
    - Check byte SB0 of subpacket 0.
    - If SB0 does not equal 0x00, 0x01, or 0x10 then FAIL
    - Check bytes SB1…SB6 of subpacket 0.
    - If any SB1…SB6 does not equal 0x00 then FAIL
    - Compare SB0…SB6 of subpacket 0 with SB0…SB6 of subpackets 1, 2 and 3. Likewise, compare subpacket 1 with subpacket 2 and 3 and compare subpacket 2 with subpacket 3.
    - If any subpacket differs from any other then FAIL
    - If this General Control Packet was transmitted anywhere except between an active edge of VSYNC and 384 pixels following that same edge → FAIL
  - If packet type is equal to 0x04 (ACP Packet)
    - Note that ACP Packet has been received
    - If the value of HB1(ACP_type) is not equal to any of the following: 0x00, 0x01, 0x02, 0x03 then FAIL, (optionally continue to next packet)

- If ACP_type equals to 0x00 (Generic Audio) or 0x01(IEC 60958 conformant)
  - Check byte HB2 and PB0 through PB27
  - If these reserved field is not zeros then FAIL
- If ACP_type equals to 0x02 (DVD Audio)
  - Check byte HB2 and PB2 through PB27
  - If these reserved fields are not zero then FAIL
  - Check byte PB0
  - If the value is not equal to 0x01 then FAIL
  - Check the transmission timing of ACP packet.
  - If the ACP packet is not transmitted at least once per 300msec then FAIL
  - Check the existence of ISRC1 Packet
  - If ISRC1 Packet is not transmitted then FAIL
- If ACP_type equals to 0x03 (Super Audio CD)
  - Check byte HB2 and PB2 through PB27
  - If these reserved fields are not zero then FAIL
  - Check the transmission timing of ACP packet.
  - If the ACP packet is not transmitted at least once per 300msec then FAIL

- If packet type is equal to 0x05 (ISRC1)
  - Note that ISRC1 Packet has been received
  - Check following Reserved field
    - Bit 3,4, and 5 of HB1
    - HB2
    - PB16 through PB27
  - If these reserved fields are not zero then FAIL
  - If the value of ISRC_Cont is one
    - Check the existence of ISRC2 Packet in the subsequent Packets
    - If ISRC2 Packet is not transmitted then FAIL
  - If the value of ISRC_Cont is zero
    - Check the existence of ISRC2 Packet in the subsequent Packets
    - If ISRC2 Packet is transmitted then FAIL
- If packet type is equal to 0x06 (ISRC2)
  - Note that ISRC2 Packet has been received
  - Check following Reserved field
    - HB1
    - HB2
    - PB16 through PB27
  - If these reserved fields are not zero then FAIL

- If ACP or ISRC1 or ISRC2 packet was received during the test,
  - Change HDMI VSDB in Protocol Analyzer to length = 5 or Supports_AI=0.
  - Repeat entire test procedure
  - If any ACP, ISRC1 or ISRC2 packet is transmitted then FAIL

Recommended Test Method — Test ID 7-19: Packet Types

Note: Panasonic UITA-1000 cannot be used for One Bit Audio testing or testing of ACP_Type value of Super Audio CD.

1) Setup Source DUT and Protocol Analyzer and operate Source DUT as described above.
2) Configure Protocol Analyzer with HDMI VSDB of length 6 with Supports_AI = 1
3) HDMI Analysis command: ’Full HDMI Compliance‘ or ’Packet Types’
4) If HDMI Analysis reports ‘PASS’, then PASS, else FAIL
5) If ACP, ISRC1 or ISRC2 packet is received during test:
   6) Configure Protocol Analyzer with HDMI VSDB of length 5
   7) HDMI Analysis command: ’Full HDMI Compliance‘ or ’Packet Types’
   8) If HDMI Analysis reports ‘PASS’, then PASS, else FAIL
   9) If ACP, ISRC1 or ISRC2 packet is received during test then FAIL

7.5 Source – Video

Test ID 7-20: Reserved

Test ID 7-21: Minimum Format Support

Reference	Requirement
[HDMI: 6.2.1] Format Support Requirements	An HDMI Source shall support at least one of the following video format timings: 640x480p @ 59.94/60Hz 720x480p @ 59.94/60Hz 720x576p @ 50Hz

Test Objective

Verify that Source meets minimum Video Format support requirement.

Required Test Method

1) Check CDF field Source_Video_Formats for any of the following video format timings.
   - 640x480p @ 59.94/60Hz 4:3 (Format 1)
   - 720x480p @ 59.94/60Hz 4:3 (Format 2) or 16:9 (Format 3)
   - 720x576p @ 50Hz 4:3 (Format 17) or 16:9 (Format 18)
2) If CDF contains any of the video format timings then PASS
3) Else, FAIL

Recommended Test Method

Perform steps in Required Test Method.

Test ID 7-22: Additional Format Support

Reference	Requirement
[HDMI: 6.2.1] Format Support Requirements	"An HDMI Source that is capable of transmitting any of the following video format timings using any other component analog or uncompressed digital video output, shall be capable of transmitting that video format timing across the HDMI interface. 1280x720p @ 59.94/60Hz 1920x1080i @ 59.94/60Hz 720x480p @ 59.94/60Hz 1280x720p @ 50Hz 1920x1080i @ 50Hz 720x576p @ 50Hz"

Test Objective

Verify that Source is capable of transmitting formats required due to similar support on non-HDMI interfaces.

Required Test Method

1) For each of the rows in table below, If CDF field in column "If CDF field…is 'Y'" then:
   2) Check CDF field Source_Video_Formats for the CEA format number(s) in column "CDF…must contain value below"
   3) If none of these formats is in CDF field Source_Video_Formats then FAIL, "Missing <Comment text>"

If CDF field below == 'Y'	CDF Source_Video_Formats must indicate "Y" for format number below:	Comment text
Source_480p60_Other	2 or 3	480p60
Source_720p60_Other	4	720p60
Source_1080i60_Other	5	1080i60
Source_576p50_Other	17 or 18	576p50
Source_720p50_Other	19	720p50
Source_1080i50_Other	20	1080i50

Recommended Test Method

Perform steps in Required Test Method to manually verify CDF entries.

Test ID 7-23: Pixel Encoding – RGB to RGB-only Sink

Reference	Requirement
[HDMI: 6.2.3] Pixel Encoding Requirements	"All HDMI Sources shall be capable of supporting RGB 4:4:4 pixel encoding."
[HDMI: 6.2.3] Pixel Encoding Requirements	"An HDMI Source may determine the pixel-encodings that are supported by the Sink through the use of the E-EDID. If the Sink indicates that it supports YC_BC_R-formatted video data and if the Source can deliver YC_BC_R data, then it can enable the transfer of this data across the link."
[861-D: Table 8] AVI InfoFrame Data Byte 1	<See reference for details (Y1, Y0 field).>

Test Objective

Verify that the Source DUT always outputs required pixel encoding (RGB), which also correlates with AVI fields Y0 and Y1 when connected to an RGB-only Sink.

Required Test Method

1) For each video format timing listed in CDF field Source_Video_Formats, perform the following tests. Only one aspect ratio for each of the dual-aspect ratio timings needs to be tested.

    2) Attach Source DUT to Video Picture Analyzer containing a valid HDMI EDID with bits 4 and 5 of byte 3 of the CEA EDID Timing Extension both clear (0).3) Operate Source DUT to output video using material or a pattern that can clearly indicate, on the attached Sink, whether the proper pixel encoding is being used.

    4) Examine video output and any AVI InfoFrame transmitted from Source.

    [Verify that transmitted video uses RGB pixel encoding.]

        5) Examine image on Video Picture Analyzer.

        6) If image appears to be transmitted with a non-RGB pixel encoding then FAIL

    7) If CDF field Source_AVI_Supported == 'Y':

        [Verify that an AVI InfoFrame is transmitted on every two video fields.]

        8) If any two video fields occur with no AVI InfoFrame then FAIL

    [Verify that any transmitted AVI InfoFrame is correct and indicates RGB pixel encoding]

    9) For every AVI InfoFrame,

        10) If field Y1 and Y0 does not indicate RGB encoding (0, 0) then FAIL

Recommended Test Method

1) For each format listed in CDF field Source_Video_Formats perform the following tests. Only one aspect ratio for each of the dual-aspect ratio timings needs to be tested.

    2) Perform Required Test Method using a Recommended Video Picture Analyzer.

3) Verify, that the indicated pixel encoding (AVI Y0 and Y1 fields in AVI) corresponds to RGB.

4) By viewing the video output, verify that the transmitted pixel encoding is RGB (as shown in Required Test Method above).

PASS/FAIL criteria are defined above.

Test ID 7-24: Pixel Encoding – YC_BC_R to YC_BC_R Sink

Reference	Requirement
[HDMI: 6.2.3] Pixel Encoding Requirements	"All HDMI Sources shall support either YC_BC_R 4:2:2 or YC_BC_R 4:4:4 pixel encoding whenever that device is capable of transmitting a color-difference color space across any other component analog or digital video interface."
[HDMI: 6.5] Pixel Encodings	<See reference for details.>
[861-D: 6.4] Auxiliary Video Information (AVI) InfoFrame	<See reference for details.>

Test Objective

Verify that the Source DUT always outputs pixel encoding that correlates with AVI fields Y0 and Y1 when presented with a YC_BC_R-capable Sink and that DUT is capable of supporting YC_BC_R pixel encoding when required.

Required Test Method

1) For each video format timing listed in CDF field Source_Video_Formats perform the following tests. Only one aspect ratio for each of the dual-aspect ratio timings needs to be tested.

    2) Attach Source DUT to Video Picture Analyzer containing avalid HDMI EDID with

        - bits 4 and 5 of byte 3 of the CEA EDID Timing Extension both set (1).

    3) Operate Source DUT to output video using material or a pattern that can clearly indicate, on the attached Sink, whether the proper color space is being used.

    4) If Source supports YC_BC_R transmission (CDF field Source_HDMI_YCBCR is "Y"), configure the DUT to transmit YC_BC_R pixel encoding.

    5) If CDF field Source_AVI_Supported == 'Y':

        [Verify that an AVI InfoFrame is transmitted on every two video fields.]

        6) If any two video fields occur with no AVI InfoFrame then FAIL

    7) Examine video output and all AVI InfoFrames transmitted from Source.

    8) For every AVI InfoFrame,

        9) If AVI Y1 and Y0 fields do not indicate same pixel encoding as is used in transmitted video then FAIL

        10) If CDF field Source_HDMI_YCBCR is "Y" :

            11) If transmitted video uses RGB pixel encoding then FAIL

12) If any transmitted AVI InfoFrame indicates RGB pixel encoding then FAIL

13) Repeat for remaining video formats.

Recommended Test Method

1) For each format listed in CDF field Source_Video_Formats perform the following tests. Only one aspect ratio for each of the dual-aspect ratio timings needs to be tested.

2) Attach Source DUT to Panasonic UITA-1000 and set the DVI/HDMI EDID switch to HDMI (up) position and the right switch to position A or C. (EDID indicates support for YC_BC_R).

3) Operate Source DUT to output video using material or a pattern that can clearly indicate, on the attached Sink, whether the proper color space is being used.

4) If Source supports YC_BC_R transmission (CDF field Source_HDMI_YCBCR is “Y”), configure the DUT to transmit YC_BC_R pixel encoding.

5) Capture the stream using the Panasonic UITA-1000

6) Verify, that the indicated pixel encoding (AVI Y0 and Y1 fields) corresponds to the transmitted pixel encoding

7) By viewing the video output, verify that YCbCr pixel encoding is used when supported (as shown in Required Test Method above).

Test ID 7-25: Video Format Timing

Reference	Requirement
[HDMI: 6.3] Video Format Timing Support”	“All specified video line pixel counts and video field line counts (both active and total) and HSYNC and VSYNC positions and durations shall be adhered to when transmitting a specified video format timing.”
[861-D: Chapter 4] VIDEO FORMATS AND WAVEFORM TIMINGS”	<See reference for details.>

Test Objective

Verify that Source DUT, whenever transmitting any CEA video format, complies with all required pixel and line counts and pixel clock frequency range.

Required Test Method

ATC testing is required to verify active and total counts for both horizontal and vertical as well as HSYNC and VSYNC polarity. The ATC may optionally verify all other parameters.

- ❑ Connect Source DUT to a Video Timing Analyzer.

For each video format timing listed in CDF field Source_Video_Formats perform the following. Only one aspect ratio for each of the dual-aspect ratio timings needs to be tested.

- ❑ Operate Source DUT to output the tested format at a color depth of 24 bits/pixel. For all of the following, refer to the values listed in Table 7-1 and Table 7-2 for the tested format.
- ❑ If CDF field Source_AVI_Required is 'Y':
  - [Verify that at least one AVI InfoFrame is transmitted within every two video fields.]
  - If any two video fields occur with no AVI InfoFrame then FAIL
- ❑ With a frequency counter, measure the pixel clock rate.
- ❑ For any video format listed in Table 7-1 and Table 7-2 as 60Hz, 30Hz, 24Hz, 120Hz or 240Hz, pixel clock may be +0.5%/-0.6% of the listed pixel rate to allow for lower vertical rates than those listed (59.94Hz vs. 60Hz, etc.). Formats listed as 25Hz, 50Hz, 100Hz or 200Hz must be +0.5%/-0.5% of the listed pixel rate.
- ❑ If pixel clock is outside of allowable range then FAIL
- ❑ From beginning of capture data, scan for first Video Data Period in capture.
- ❑ Examine HSYNC and VSYNC values at last pixel before transition to Video Data Period.
- ❑ If HSYNC == 1 then HS_POLARITY = 0, else HS_POLARITY = 1
- ❑ If VSYNC == 1 then VS_POLARITY = 0, else VS_POLARITY = 1
- ❑ If either value HS_POLARITY or VS_POLARITY do not equal values for the selected video format then FAIL
- ❑ For each HSYNC active edge, examine all HSYNC and Video Data Periods to calculate following variables:
  - HS_LEN = number of pixels that HSYNC remains active
  - VIDEO_TO_HS = number of pixels from end of Video Data Period to HSYNC active edge
  - H_ACTIVE = number of pixels in Video Data Period minus 2 (for Guard Band)
  - H_TOTAL = number of pixels between two HSYNC active edges
  - If any value HS_LEN, HS_TO_VIDEO, H_ACTIVE and H_TOTAL do not equal values for the selected video format then FAIL
- ❑ Examine VSYNC/HSYNC relationship for two video fields.
- ❑ If VSYNC active edge alternates from field to field between coincident with HSYNC and mid-point between two HSYNC active edges then SCAN = INTERLACED
  - If VSYNC is coincident with HSYNC on every field then SCAN = PROGRESSIVE
- ❑ For each VSYNC active edge, calculate following variables:
  - VS_LEN = number of pixels that VSYNC remains active divided by H_TOTAL, rounded to nearest half-integer (i.e. 6 or 6.5).
  - V_ACTIVE = number of Video Data Periods between each two VSYNC active edges
  - V_TOTAL = number of pixels between VSYNC active edges divided by H_TOTAL, rounded to nearest half-integer
  - If SCAN == PROGRESSIVE, examine all VSYNC, HSYNC and Video Data Periods to calculate following variables
    - VS_TO_VIDEO = number of HSYNC pulses between VSYNC active edge and first subsequent Video Data Period, not including HSYNC pulse that is coincident (or nearly so) with VSYNC active edge

- If SCAN == INTERLACED, examine all VSYNC, HSYNC and Video Data Periods to calculate following variables:
  - VS_TO_VIDEO = number of HSYNC pulses between VSYNC active edge and first subsequent Video Data Period, not including (for Field 1) HSYNC pulse that is coincident (or nearly so) with VSYNC active edge or (for Field 2) HSYNC pulse following VSYNC edge by ½ line
- If any value VS_LEN, VS_TO_VIDEO, V_ACTIVE and V_TOTAL do not equal values for the selected video format then FAIL

❑ Determine CEA Video Code for the transmitted format. Note for subsequent tests.

Recommended Test Method

1) For each format listed in CDF field Source_Video_Formats perform the following tests.
   2) Perform Required Test Method using a Recommended Video Timing Analyzer.
      - With a frequency counter, measure the pixel clock rate and enter this value to the test equipment.
      - HDMI Analysis command: ’Full HDMI Compliance‘ or ’Video Format Timing’
   3) If HDMI Analysis reports ‘PASS’, then PASS, else FAIL

CEA Video Code	Format	Pixel Clock (MHz)	H_ TOTAL Pixels	H_ ACTIVE Pixels	VID_ TO_HS clocks	HS_ POLR'Y	HS_ LEN clocks
1	640x480p @ 60 Hz	25.2	800	640	16	–	96
2,3	720x480p @ 60 Hz	27.027	858	720	16	–	62
4	1280x720p @ 60 Hz	74.25	1650	1280	110	+	40
5	1920x1080i @ 60 Hz	74.25	2200	1920	88	+	44
6,7	720(1440)x480i @ 60 Hz	27.027	1716	1440	38	–	124
8,9	720(1440)x240p @ 60 Hz	27.027	1716	1440	38	–	124
10,11	2880x480i @ 60 Hz	54.054	3432	2880	76	–	248
12,13	2880x240p @ 60 Hz	54.054	3432	2880	76	–	248
14,15	1440x480p @ 60 Hz	54.054	1716	1440	32	–	124
16	1920x1080p @ 60 Hz	148.5	2200	1920	88	+	44
17,18	720x576p @ 50 Hz	27.0	864	720	12	–	64
19	1280x720p @ 50 Hz	74.25	1980	1280	440	+	40
20	1920 x 1080i @ 50 Hz	74.25	2640	1920	528	+	44
21,22	720(1440)x576i @ 50 Hz	27.0	1728	1440	24	–	126
23,24	720(1440)x288p @ 50 Hz	27.0	1726	1440	24	–	126
25,26	2880x576i @ 50 Hz	54.0	3456	2880	48	–	252
27,28	2880x288p @ 50 Hz	54.0	3456	2880	48	–	252
29,30	1440x576p @ 50 Hz	27.0	1728	1440	24	–	128
31	1920x1080p @ 50 Hz	148.5	2640	1920	528	+	44
32	1920x1080p @ 24 Hz	74.25	2750	1920	638	+	44
33	1920x1080p @ 25 Hz	74.25	2640	1920	528	+	44
34	1920x1080p @ 30 Hz	74.25	2200	1920	528	+	44
35,36	2880x480p @ 60Hz	108.108	3432	2880	64	–	248
37,38	2880x576p @ 50Hz	108.0	3456	2880	48	+	252
39	1920x1080i/1250 total @ 50Hz	72.0	2304	1920	32	–	168
40	1920x1080i @ 100Hz	148.5	2640	1920	528	+	44
41	1280x720p @ 100Hz	148.5	1980	1280	440	+	40
42,43	720x576p @ 100Hz	54.0	864	720	12	–	64
44,45	720(1440)x576i @ 100Hz	54.0	1728	1440	24	–	126
46	1920x1080i @ 120Hz	148.5	2200	1920	88	+	44
47	1280x720p @ 120Hz	148.5	1650	1280	110	+	40
48,49	720x480p @ 120Hz	54.054	858	720	16	–	62
50,51	720(1440)x480i @ 120Hz	54.054	1716	1440	38	–	124
52,53	720X576p @ 200Hz	108.0	864	720	12	–	64
54,55	720(1440)x576i @ 200Hz	108.0	1728	1440	24	–	126
56,57	720x480p @ 240Hz	108.108	858	720	16	–	62
58,59	720(1440)x480i @ 240Hz	108.108	1716	1440	38	–	124

Table 7-1 Video Format Timing – Horizontal and Clock Parameters

CEA Video Code	Format	V_ TOTAL (lines)	V_ ACTIVE (lines)	VS_ TO_VID (lines)	VS_ LEN (lines)	VS_ POLR'Y	HV _OFFSET (pixels)
1	640x480p @ 60 Hz	525	480	35	2	–	0
2,3	720x480p @ 60 Hz	525	480	36	6	–	0
4	1280x720p @ 60 Hz	750	720	25	5	+	0
5	1920x1080i @ 60 Hz	562.5	540	20	5	+	0 / 1100
6,7	720(1440)x480i @ 60 Hz	262.5	240	18	3	–	0 / 858
8,9	720(1440)x240p @ 60 Hz	262 or 263	240	18	3	–	0
10,11	2880x480i @ 60 Hz	262.5	240	18	3	–	0 / 1716
12,13	2880x240p @ 60 Hz	262 or 263	240	18	3	–	0
14,15	1440x480p @ 60 Hz	525	480	36	6	–	0
16	1920x1080p @ 60 Hz	1125	1080	41	5	+	0
17,18	720x576p @ 50 Hz	625	576	44	5	–	0
19	1280x720p @ 50 Hz	750	720	25	5	+	0
20	1920 x 1080i @ 50 Hz	562.5	540	20	5	+	0 / 1320
21,22	720(1440)x576i @ 50 Hz	312.5	288	22	3	–	0 / 864
23,24	720(1440)x288p @ 50 Hz	312…314	288	22	3	–	0
25,26	2880x576i @ 50 Hz	312.5	288	22	3	–	0 / 1728
27,28	2880x288p @ 50 Hz	312…314	288	22	3	–	0
29,30	1440x576p @ 50 Hz	625	576	22	5	–	0
31	1920x1080p @ 50 Hz	1125	1080	41	5	+	0
32	1920x1080p @ 24 Hz	1125	1080	41	5	+	0
33	1920x1080p @ 25 Hz	1125	1080	41	5	+	0
34	1920x1080p @ 30Hz	1125	1080	41	5	+	0
35,36	2880x480p @ 60Hz	525	480	36	6	–	0
37,38	2880x576p @ 50Hz	625	576	22	5	+	0
39	1920x1080i/1250 total @ 50Hz	625	540	62	5	+	0 / 1152
40	1920x1080i @ 100Hz	562.5	540	20	5	+	0 / 1320
41	1280x720p @ 100Hz	625	576	44	5	+	0
42,43	720x576p @ 100Hz	625	576	44	5	–	0
44,45	720(1440)x576i @ 100Hz	312.5	288	22	3	–	0 / 864
46	1920x1080i @ 120Hz	562.5	540	20	5	+	0 / 1100
47	1280x720p @ 120Hz	750	720	25	5	+	0
48,49	720x480p @ 120Hz	525	480	36	6	–	0
50,51	720(1440)x480i @ 120Hz	262.5	240	18	3	–	0 / 858
52,53	720X576p @ 200Hz	625	576	44	5	–	0
54,55	720(1440)x576i @ 200Hz	312.5	288	22	3	–	0 / 864
56,57	720x480p @ 240Hz	525	480	36	6	–	0
58,59	720(1440)x480i @ 240Hz	262.5	240	18	3	–	0 / 858

Table 7-2 Video Format Timing – Vertical Parameters

Regarding all 60Hz-class formats:

- as per CEA-861-D, all non-HDTV formats must be listed in the EDID at a 59.94Hz vertical frequency while HDTV formats must be listed as 60Hz. Note that pixel clock frequencies shown here all correspond to 60Hz frame rates, for ease and consistency in testing.
- Pixel clock may be +0.5%/-0.6% of the listed pixel rate to allow for lower vertical rates than those listed (59.94Hz vs. 60Hz, etc.).

Note: Interlaced formats alternate between HSYNC/VSYNC coincident and HSYNC/VSYNC offset by ½ line. The values in column HV_OFFSET above represent the HSYNC/VSYNC offset for each of the two repeating interlaced fields.

Note: Primary and secondary formats are indicated in the tables above as:

	Primary Format
	Secondary Format

Test ID 7-26: Pixel Repetition

Reference	Requirement
[HDMI: Table 8-3] HDMI Valid Pixel Repeat Values for Each Format	<See reference for details, summarized in Table 7-3, below.>

Test Objective

Verify that Source DUT indicates Pixel Repetition values in the AVI as required and that the pixels are actually repeated the indicated number of times.

Required Test Method

Connect Source DUT to a Video Timing Analyzer. For each video format timing listed in CDF field Source_Video_Formats, perform the following tests. Only one aspect ratio for each of the dual-aspect ratio timings needs to be tested.

These verifications assume that the Video Format Timing test has been executed and passed for the transmitted format and that the CEA Video Code has been determined.

- For the following, refer to the row in Table 7-3 corresponding to the transmitted video format timing.
- If no AVI is transmitted:
  - If column “No AVI Value” contains “illegal” then FAIL
  - If column “No AVI Value” contains the value 1 (meaning that the pixel is sent twice):

    - Examine each group of two video pixels (i.e. corresponding to two 10-bit TMDS characters) in each Video Data Period. For each group (H_ACTIVE / 2 groups):
        - Verify that both video pixels in the group are identical. If they are different then FAIL

- If AVI is transmitted, examine PR value (PR = PR3*8 + PR2*4 + PR1*2 + PR0):
  - If PR value is not listed in column “Legal PR Values” then FAIL
  - If PR != 0:
    - Examine each group of PR+1 video pixels (i.e. corresponding to PR+1 10-bit TMDS characters) in each Video Data Period. For each group (H_ACTIVE / (PR+1)):
        - Verify that all PR+1 video pixels in the group are identical. If any are different from the others then FAIL

Recommended Test Method

1) For each format listed in CDF fields Source_Video_Formats perform the following tests.

    2) Setup Source DUT and video Timing Analyzer and operate Source DUT as described above.

        - HDMI Analysis command: ’Full HDMI Compliance‘ or ‘Pixel Repetition’

    3) If HDMI Analysis reports ‘PASS’, then PASS, else FAIL

Table 7-3 Pixel Repeat Values

CEA Video Code	Video Description	No AVI Value	Legal PR Values
1	640x480p @ 60Hz	0	0
2,3	720x480p @ 59.94/60Hz	0	0
4	1280x720p @ 59.94/60Hz	0	0
5	1920x1080i @ 59.94/60Hz	0	0
6,7	720(1440)x480i @ 59.94/60Hz	1	1
8,9	720(1440)x240p @ 59.94/60Hz	1	1
10,11	2880x480i @ 59.94/60Hz	Illegal	0, 1,…9
12,13	2880x240p @ 59.94/60Hz	Illegal	0, 1,…9
14,15	1440x480p @ 59.94/60Hz	Illegal	0, 1
16	1920x1080p @ 59.94/60Hz	0	0
17,18	720x576p @ 50Hz	0	0
19	1280x720p @ 50Hz	0	0
20	1920x1080i @ 50Hz	0	0
21,22	720(1440)x576i @ 50Hz	1	1
23,24	720(1440)x288p @ 50Hz	1	1
25,26	2880x576i @ 50Hz	Illegal	0, 1,…9
27,28	2880x288 @ 50Hz	Illegal	0, 1,…9
29,30	1440x576p @ 50Hz	Illegal	0, 1
31	1920x1080p @ 50Hz	0	0
32	1920x1080p @ 23.97/24Hz	0	0
33	1920x1080p @ 25Hz	0	0
34	1920x1080p @ 29.97/30Hz	0	0
35,36	2880x480p @ 60Hz	Illegal	0, 1, 3
37,38	2880x576p @ 50Hz	Illegal	0, 1, 3
39	1920x1080i (1250 total) @ 50Hz	0	0
40	1920x1080i @ 100Hz	0	0
41	1280x720p @ 100Hz	0	0
42,43	720x576p @ 100Hz	0	0
44,45	720(1440)x576i @ 100Hz	1	1
46	1920x1080i @ 120Hz	0	0
47	1280x720p @ 120Hz	0	0
48,49	720x480p @ 120Hz	0	0
50,51	720(1440)x480i @ 120Hz	1	1
52,53	720X576p @ 200Hz	0	0
54,55	720(1440)x576i @ 200Hz	1	1
56,57	720x480p @ 240Hz	0	0
58,59	720(1440)x480i @ 240Hz	1	1

Test ID 7-27: AVI InfoFrame

Reference	Requirement
[HDMI: 8.2.1] Auxiliary Video Information	<See reference for details>
[861-D: 6.1] Auxiliary Video Information (AVI) InfoFrame	"If the source device supports the transmission of the Auxiliary Video Information (AVI) and if it determines that the DTV Monitor is capable of receiving that information, it shall send the AVI to the DTV Monitor once per frame." "The information on 'Active Format Aspect Ratio,' bar widths, overscan/underscan, non-uniform picture scaling, and colorimetry is information that can be used by the DTV Monitor…If this information is present at the source device and valid…it is required that this information be sent."

Test Objective

Verify that at least one AVI InfoFrame is transmitted for every two video fields when required and that any AVI InfoFrame transmitted is accurate.

Required Test Method

Note that, for any of the following tests that check the M1, M0 (picture aspect ratio) or VIC (Video Identification Code) fields of the AVI or the picture aspect ratio of the transmitted video, the check must be performed when the DUT is processing content that has an aspect ratio indication that is correctly indicated and that is known to the test operator. If this condition cannot be achieved then that test step should be skipped.

- ❑ [Verify that CDF field Source_AVI_Required is set correctly]
- ❑ If CDF field Source_AVI_Required is 'N':
  - [AVI InfoFrame must be transmitted once per frame whenever Source supports the transmission of the AVI InfoFrame.]
    - If CDF field Source_HDMI_YCBCR is 'Y' then FAIL
  - [AVI shall be sent when 2880x240, 288, 480 or 576-line format is transmitted or 1440x480p or 1440x576p. That is, formats 10-15 and 25-30. If Source is capable of transmitting any of these formats, it is required to transmit AVI.]
    - If CDF field Source_Video_Formats includes any of the following: 10, 11, 12, 13, 14, 15, 25, 26, 27, 28, 29, 30 then FAIL
  - [AVI shall be sent when Source is transmitting any video format timing listed in EDID with multiple aspect ratios.]
    - If CDF field Source_Video_Formats includes any of the following pairs: 2 and 3, 6 and 7, 8 and 9, 10 and 11, 12 and 13, 14 and 15, 17 and 18, 21 and 22, 23 and 24, 25 and 26, 27 and 28, or 29 and 30: then FAIL
  - [AVI shall be transmitted whenever the Active Format, Bar, Overscan/Underscan, Scaling, or Colorimetry information is available and valid at the Source.]
    - If CDF field Source_AVI_Info_Available is 'Y' then FAIL

- [AVI InfoFrame shall be transmitted whenever the Source uses alternate colorimetry.]
  - If CDF field Source_Alt_Colorimetry is 'Y' then FAIL
- [AVI InfoFrame shall be transmitted if Source has no Aspect Ratio Converter.]
  - If CDF field Source_AR_Converter is 'N' then FAIL

❑ If CDF field Source_AVI_Required == 'Y' and Source_AVI_Supported == 'N' then FAIL

❑ For each video format listed in CDF field Source_Video_Formats, perform the following tests.

- Connect Source DUT to a Video Picture Analyzer.
- [Verify that AVI InfoFrame is transmitted once per frame if Source is required to use AVI InfoFrame]
  - If CDF field Source_AVI_Supported == 'Y':
    - If any two video fields occur with no AVI InfoFrame then FAIL
- [Verify that only AVI InfoFrame v2 is transmitted (no v1 or other) whenever AVI InfoFrame is transmitted at all.]
  - If AVI is transmitted and InfoFrame_version field (byte HB1) is not 2 then FAIL
- [AVI M1, M0 bits (picture aspect ratio) must match transmitted video format.]
  - Attempt to make Source DUT output video with each of its supported aspect ratios at both SD and HD video format timings (if supported).
  - If AVI M0-M1 field indicates an aspect ratio not permitted for the transmitted video format timing then FAIL
  - If content processed by DUT has a correctly indicated aspect ratio which is known to the operator and consists of an image which has an easily determined aspect ratio, perform the following:
    - View image to determine transmitted picture aspect ratio and compare to aspect ratio information in AVI.
    - If AVI is transmitted and AVI M0-M1 fields do not correspond to viewed image then FAIL
- [Whenever transmitting a CEA video format, any transmitted AVI InfoFrame, VIC field (Video Identification Code) must be non-zero and accurate.]
  - If Source DUT is outputting a CEA format and the transmitted AVI VIC field does not correspond to one of the video identification codes corresponding to the transmitted video format timing then FAIL
  - If AVI M1, M0 fields are 0, 1 (4:3) or 1, 0 (16:9) and do not match aspect ratio corresponding to transmitted VIC field then FAIL
- [All reserved fields in AVI InfoFrame shall be zero.]
  - If PB1 bit 7 is non-zero then FAIL
  - If PB4 bit 7 is non-zero then FAIL
  - If PB5 any bit 4-7 is non-zero then FAIL
  - If any byte PB14 to PB27 is non-zero then FAIL
- [Q field shall be a default value if EDID does not indicate QS.]
  - If source is transmitting YCbCr:

        - If Q1/Q0 is not 00 (Default) or 01 (Limited Range) then FAIL
    - Else (source is transmitting RGB)
        - If transmitting 640x480p then
            - if Q1/Q0 is not 00 (Default) or 10 (Full Range) then FAIL
        - else
            - If Q1/Q0 is not 00 (Default) or 01 (Limited Range) then FAIL

- [Whenever transmitting a non-CEA format, any transmitted AVI InfoFrame, VIC field must be zero.]
    - Attempt to make Source DUT output video using a non-CEA format.
    - If CDF field Source_Non-CEA_Formats = "Y":
        - Attempt to make Source DUT output video using a non-CEA format.
        - If AVI VIC field is not zero then FAIL

Recommended Test Method

Note: Panasonic UITA-1000 cannot be used when DUTs set Q, EC or ITC fields

For each video format listed in CDF fields Source_Video_Formats, perform the following tests.

Using the Video Picture Analyzer, perform the steps in the Required Test Method above. For testing of DVD players, use the following test patterns from the "Digital Video Essentials (DVE)" disk, available from Joe Kane Productions:

- For 16:9 testing:
    - Title 12 "Video Test Signals, Display Setup Patterns", Chapter 19, "1.78 Aspect Ratio & Geometry Pattern"
- For 4:3 testing:
    - Title 15 "Video Test Signals, 1.33 Patterns", Chapter 2, "Convergence, 1.33:1 linear"

7.6 Source – Audio

Test ID 7-28: IEC 60958/IEC 61937

Reference	Requirement
[HDMI: 7.1] Relationship with IEC 60958/IEC 61937	<See reference for details.>
[HDMI: 7.3] Audio Sample Rate and Support Requirements	"An HDMI audio stream shall only indicate values shown in Table 7-4."

Test Objective

Verify that the behavior of all fields within the Audio Sample or High Bitrate Audio Stream Subpackets follow the corresponding rules specified in the IEC 60958 or IEC 61937 specifications.

Required Test Method

If CDF field Source_Basic_Audio == 'N' then

- Examine DUT for any other audio output (analog RCA, S/PDIF, etc.).
- If any other audio output present on DUT, then FAIL

Else (CDF field Source_Basic_Audio == 'Y')

- Configure the Source to output 480p (or 576p if 480p is not supported) with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.
  - For each Audio Sample packet, if Layout = 0, each audio sample is indicated by an SP bit. If Layout = 1, each Audio Sample packet represents one audio sample.
    - Count audio samples between indicated B bit.
    - If repetition period of B bit is not 192 "Frames" (2-channel samples) then FAIL
    - Get nominal Frame Rate from the Channel/Status bits 24 to 27.

Channel Status Bit Number				Sample Frequency or Frame Rate
24	25	26	27	
1	1	0	0	32 kHz
0	0	0	0	44.1 kHz
0	0	0	1	88.2 kHz
0	0	1	1	176.4 kHz
0	1	0	0	48 kHz
0	1	0	1	96 kHz
0	1	1	1	192 kHz
1	0	0	1	768 kHz

    - If the Frame Rate is not listed above then FAIL
    - If the Frame Rate is > 192kHz then FAIL

- ❑ If the Source supports >2 channel audio, configure the Source to output the highest available sampling rate with the greatest number of channels.
  - For each Audio Sample packet, if Layout = 0, each audio sample is indicated by an SP bit. If Layout = 1, each Audio Sample packet represents one audio sample.
    - Count audio samples between indicated B bit.
    - If repetition period of B bit is not 192 "Frames" (2-channel samples) then FAIL
    - Get nominal Frame Rate from the Channel/Status bits 24 to 27.
    - If the Frame Rate is not listed above then FAIL
    - If the Frame Rate is > 192kHz then FAIL
- ❑ If the Source supports high bitrate audio (CDF field Source_HBRA), configure the Source to output such a format.
  - For each High Bitrate Audio Stream packet, each subpacket represents one IEC 60958 "frame".
    - Count frames between indicated B bit.
    - If repetition period of B bit is not 192 Frames then FAIL
    - Get nominal Frame Rate from the Channel/Status bits 24 to 27.
    - If the Frame Rate is not listed above then FAIL
    - If the Frame Rate is <= 192kHz then FAIL

Recommended Test Method

Note: Panasonic UITA-1000 cannot be used for High Bitrate Audio testing.

1) If CDF field Source_Basic_Audio == 'N' then
    2) Examine DUT for any other audio output (analog RCA, S/PDIF, etc.).
    3) If any other audio output present on DUT, then FAIL
4) Else (CDF field Source_Basic_Audio == 'Y'):
    5) Setup Source DUT and Audio Timing Analyzer
    6) Power on DUT and configure to output audio.
    7) Configure the Source to output 480p (or 576p if 480p is not supported) with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.
        8) HDMI Analysis command: 'Full HDMI Compliance' or 'Audio IEC Compliance'
        9) If HDMI Analysis reports 'PASS', then PASS, else FAIL
    10) If Source supports multi-channel audio, configure to output multi-channel audio.
        11) HDMI Analysis command: 'Full HDMI Compliance' or 'Audio IEC Compliance'
        12) If HDMI Analysis reports 'PASS', then PASS, else FAIL
    13) If Source supports a high-bitrate audio stream format (e.g. DTS-HD or Dolby MAT), configure to output one such format.
        14) HDMI Analysis command: 'Full HDMI Compliance' or 'Audio IEC Compliance'
        15) If HDMI Analysis reports 'PASS', then PASS, else FAIL

Test ID 7-29: ACR

Reference	Requirement
[HDMI: 7.2] Audio Sample Clock Capture and Regeneration	<See reference for details.>

Test Objective

Verify that the relationship between the parameters (N, CTS, audio sample rate) is correct with respect to the Audio Clock Regeneration mechanism.

Required Test Method

If CDF field Source_Basic_Audio== 'N' then PASS

- Configure the Source to output 480p (or 576p if 480p is not supported) with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.
- [Verify N parameter value.]
  - Get nominal sampling frequency (Fs) from the Channel/Status bits 24 to 27.
  - Get N parameter from ACR packet.
  - If 128*Fs/1500 <= N <= 128*Fs/300 then continue test else then FAIL
- [Verify CTS parameter value.]
  - Monitor ACR Packets with "new" (non-zero) values of CTS
  - [Measure the actual audio sample rate (Fs_actual).]
    - Count the number of audio samples (n) over 2 seconds (Ts). Calculate Fs_actual using the following equation:
      - Fs_actual = n / Ts
  - Average the CTS values ($CTS_{average}$) over 2 seconds or more.
  - Measure the TMDS clock (f_{TMDS_clock}) with an accuracy of 1 ppm.
  - Get the nominal audio clock accuracy from the Channel/Status bits 28 and 29.
  - If clock accuracy == 50 ppm (bits 28, 29 == 1, 0)
    - if $CTS_{average}$ is within (f_{TMDS_clock} * N) / (128 * Fs) ± 50 ppm then continue test, else then FAIL
  - Else,
    - if $CTS_{average}$ is within (f_{TMDS_clock} * N) / (128 * Fs_actual) ±100 ppm then continue test, else then FAIL
- [Verify CTS transmitting interval]
  - Monitor ACR Packets with "new" (non-zero) values of CTS
  - Average new CTS transmitting interval ($CTS_{interval}$) over 2 sec or more.
  - If $CTS_{interval}$ is not within the range of (N / (128 * Fs)) ±2000ppm then FAIL

- [Verify ACR for Deep Color]
  - If Source supports Deep Color (CDF field Source_Deep_Color) then configure the Source to output a video format listed in CDF field Source_Video_Formats at 36 bits/pixel with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio and repeat test.

Recommended Test Method Test ID 7-29: ACR

Note: Panasonic UITA-1000 cannot be used when testing Deep Color modes.

1) If CDF field Source_Basic_Audio== ‘N’ then PASS
2) Setup Source DUT and Audio Timing Analyzer and operate Source DUT as described above.
3) Configure the Source to output 480p (or 576p if 480p is not supported) with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.
    4) HDMI Analysis command: ‘Full HDMI Compliance’ or ‘ACR’
    5) If HDMI Analysis reports ‘PASS’, then PASS, else FAIL
6) If Source supports Deep Color (CDF field Source_Deep_Color) then:
    7) Configure the Source to output a Primary video format at 36 bits/pixel with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio and repeat test. (If Source DUT does not support Deep Color on any Primary Video format then skip following steps.)
    8) HDMI Analysis command: ‘Full HDMI Compliance’ or ‘ACR’
    9) If HDMI Analysis reports ‘PASS’, then PASS, else FAIL

Test ID 7-30: Audio Sample Packet Jitter

Reference	Requirement
[HDMI: 7.8.1] Audio Sample Packets	<See reference for details.>

Test Objective

Verify that the source audio packet jitter is within the limits specified.

Required Test Method

If CDF field Source_Basic_Audio== ‘N’ then PASS

From the following tables of primary video formats, pick the single DUT-supported audio/video format combination with the highest value. This will be format combination #1.

861B Code	Format Description	2-channel PCM or compressed						
		32	44.1	48	88.2	96	176.4	192
1	640x480p, 60Hz (VGA)	2	3	3	6	7	12	14
2,3	720x480p, 60Hz	2	3	4	6	7	13	14
4	1280x720p, 60Hz	1	2	2	4	4	8	9
5	1920x1080i, 60Hz	2	3	3	6	6	12	13
6,7	1440x480i, 60Hz	4	6	7	12	13	25	27
17,18	720x576p, 50Hz	2	3	4	6	7	13	14
19	1280x720p, 50Hz	1	2	2	4	4	8	9
20	1920x1080i, 50Hz	2	3	3	6	6	12	13
21,22	1440x576i, 50Hz	4	6	7	12	13	25	27

861B Code	Format Description	3 or more channel PCM						
		32	44.1	48	88.2	96	176.4	192
1	640x480p, 60Hz (VGA)	9	12	14	-	-	-	-
2,3	720x480p, 60Hz	9	13	14	-	-	-	-
4	1280x720p, 60Hz	6	8	9	16	18	32	35
5	1920x1080i, 60Hz	9	12	13	24	26	47	52
6,7	1440x480i, 60Hz	18	25	27	49	54	-	-
17,18	720x576p, 50Hz	9	13	14	-	-	-	-
19	1280x720p, 50Hz	6	8	9	16	18	32	35
20	1920x1080i, 50Hz	9	12	13	24	26	47	52
21,22	1440x576i, 50Hz	18	25	27	49	54	-	-

From the following table of mandatory video and basic audio formats, pick the audio/video combination with the highest value. This will be format combination #2.

861B Code	Format Description	2-channel PCM or compressed						
		32	44.1	48				
1	640x480p, 60Hz (VGA)	2	4	6				
2,3	720x480p, 60Hz	3	5	7				
17,18	720x576p, 50Hz	3	5	7				

For each of these two combinations do the following tests. If format combination #2 matches combination #1, do not repeat the test:

- [Verify audio packet jitter]
  - Measure actual audio sample rate (Fs_actual).
  - n = number of audio samples over 2 seconds or more (= Ts).
  - Calculate Fs_actual using the following equation:
  - Fs_actual = n / Ts
  - If audio packet jitter relative to actual sampling rate does not exceed one video horizontal line period plus a single audio sample period then PASS, else then FAIL

Recommended Test Method

1) If CDF field Source_Basic_Audio== 'N' then PASS
2) Setup Source DUT and Audio Timing Analyzer.
3) Determine each of the two audio/video format combinations described in the Required Test Method above. For each of the two combinations do the following tests.
    4) Configure the Source DUT to output audio and video format combination #1.
    5) HDMI Analysis command: 'Full HDMI Compliance' or 'Audio Packet Jitter'
    6) If HDMI Analysis does not report 'PASS', then FAIL
    7) Configure the Source DUT to output audio and video format combination #2. If format combination #2 matches combination #1, do not repeat the test:
    8) HDMI Analysis command: 'Full HDMI Compliance' or 'Audio Packet Jitter'
    9) If HDMI Analysis reports 'PASS', then PASS, else FAIL

Test ID 7-31: Audio InfoFrame

Reference	Requirement
[861-D: 6.3] Audio InfoFrame	"If the source device supports the transmission of the Audio InfoFrame and if it determines that the DTV Monitor is capable of receiving…digital audio, then the Audio InfoFrame, with Data Bytes 1 through 3 set correctly, shall be sent once per video frame while digital audio is being sent across the interface."
[861-D: 6.3.1] Audio Identification Information	"If the DTV and the source device support more than "basic audio," as defined by the physical/link specification, then this information shall be sent and shall accurately identify the stream while digital audio is being sent."

Test Objective

Verify that Source transmits an Audio InfoFrame whenever required and that contents are valid.

Required Test Method

If CDF field Source_Basic_Audio== 'N' then PASS

- Configure the Source to output 480p (or 576p if 480p is not supported) with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.
- [Check Audio InfoFrame placement]
- Examine the placement of the Audio InfoFrame Packet
- If Audio InfoFrame Packet is detected at least once per two video fields then continue else then FAIL
- [Check Packet Header]
- If Packet Header has the following contents
    - HB0: 0x84 (InfoFrame Type Code)
    - HB1: 0x01
    - HB2: 0x0A (InfoFrame_length)
  - Then continue else then FAIL
- [Check Packet Body]
- Read Packet Body (PB0 to PB27)
- [Check PB1 to PB5]
  - If the value of Audio Coding Type (CT3~CT0) is 0x0 then continue else then FAIL
  - If the value of PB1 bit 3 is zero then continue else then FAIL.
  - If the value of the most significant three bits of PB2 is zero then continue else then FAIL.
  - If the value of Sampling Frequency (SF2~ SF0) is zero then continue else then FAIL.
  - If the value of Sample Size (SS1~ SS0) is zero then continue else then FAIL.
- [Check for illegal CA]
  - If CA >= 0x20 then FAIL

- [Check for valid Combination of (CA7 ~ CA0) and (CC2 ~ CC0)]
  - If indicator in Audio sample packet indicates layout 0
    - If CA!= 0x00 then FAIL
    - If CC!= 0,0,0 and CC != 0,0,1 then FAIL
  - else [layout 1]
    - FAIL if all of the following statements are false:

      CC== 0,0,0 and CA is in set { 0x01, 0x02, 0x03,…, or 0x1F }

      CC== 0,1,0 and CA is in set { 0x01, 0x02 or 0x04 }

      CC== 0,1,1 and CA is in set { 0x03, 0x05, 0x06, 0x08 or 0x14}

      CC== 1,0,0 and CA is in set { 0x07, 0x09, 0x0A, 0x0C, 0x15, 0x16, or 0x18 }

      CC== 1,0,1 and CA is in set { 0x0B, 0x0D, 0x0E, 0x10, 0x17, 0x19, 0x1A , or 0x1C }

      CC== 1,1,0 and CA is in set { 0x0F, 0x11, 0x12, 0x1B, 0x1D or 0x1E }

      CC== 1,1,1 and CA is in set { 0x13 or 0x1F }
- [If LSV is non-zero, then only 2-channels allowed (downmix)]
  - If LSV != 0x0 and CA != 0x00 then FAIL
- [Check for valid combination of DM_INH and CA]
  - If DM_INH ==1 and CA == 0x00 then FAIL
- If value of the least significant three bits of PB5 is zero then continue else then FAIL
- If value of PB6 through PB27 is 0x00. then continue else then FAIL
- [Verify checksum]
- Do a byte wide sum of HB0,HB1,HB2, PB0, PB1, PB2,…, PB10.
- If sum == 0x00 then PASS else then FAIL

Recommended Test Method

1) Setup Source DUT and Protocol Analyzer.

   2) Configure the Source to output 480p (or 576p if 480p is not supported) with 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.

   3) HDMI Analysis command: 'Full HDMI Compliance' or 'Audio InfoFrame'

   4) If HDMI Analysis reports 'PASS', then PASS, else FAIL

Test ID 7-32: Audio Sample Packet Layout

Reference	Requirement
[HDMI:5.3.4] Audio Sample Packet	See reference
[HDMI:7.6] Audio Data Packetization	See reference
[861-D: 6.3.1] Audio Identification Information	"If the DTV and the source device support more than "basic audio," as defined by the physical/link specification, then this information shall be sent and shall accurately identify the stream while digital audio is being sent."

Test Objective

Verify that Source only transmits audio using permitted Layout type.

Required Test Method

- Configure the Source to output 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.
- Read HB1 and HB2 from header
- If Audio Sample Packet Layout == 0 (Bit 4 of HB1)
  - [check for valid combinations of Sample Present and B]
  - Use the following table to check for a valid combination of Sample present and B values contained within HB1 and HB2.
  - If combination contained in HB1 & HB2 is not in this table then FAIL

Sample Present	B
0000	0000
0001	000x
0011	00bb
0111	0bbb
1111	bbbb

- Where:

  Sample Present is bits 3..0 of HB1

  B is bits 7..4 of HB2

  x is don't care

  b don't care, but only 1 bit may be set

- Configure the Source to output >2-channel PCM audio.
- If Audio Sample Packet Layout = 1 (Bit 4 of HB1).
  - [Check for valid combinations of Channel Allocation (CA), Sample Present and B]
  - Read CA from PB4 of Audio Info Frame

- Use the following table to check for a valid combination of CA, Sample present and B values.
- If combination is not in this table then FAIL

CA								Sample Present				B			
7	6	5	4	3	2	1	0	3	2	1	0	3	2	1	0
0	0	0	0	0	0	0	1	0	0	SP	SP	0	0	x	x
0	0	0	0	0	0	1	0	0	0	SP	SP	0	0	x	x
0	0	0	0	0	0	1	1	0	0	SP	SP	0	0	x	x
0	0	0	0	0	1	0	0	0	SP	0	SP	0	x	0	x
0	0	0	0	0	1	0	1	0	SP	SP	SP	0	x	x	x
0	0	0	0	0	1	1	0	0	SP	SP	SP	0	x	x	x
0	0	0	0	0	1	1	1	0	SP	SP	SP	0	x	x	x
0	0	0	0	1	0	0	0	0	SP	0	SP	0	x	0	x
0	0	0	0	1	0	0	1	0	SP	SP	SP	0	x	x	x
0	0	0	0	1	0	1	0	0	SP	SP	SP	0	x	x	x
0	0	0	0	1	0	1	1	0	SP	SP	SP	0	x	x	x
0	0	0	0	1	1	0	0	SP	SP	0	SP	x	x	0	x
0	0	0	0	1	1	0	1	SP	SP	SP	SP	x	x	x	x
0	0	0	0	1	1	1	0	SP	SP	SP	SP	x	x	x	x
0	0	0	0	1	1	1	1	SP	SP	SP	SP	x	x	x	x
0	0	0	1	0	0	0	0	SP	SP	0	SP	x	x	0	x
0	0	0	1	0	0	0	1	SP	SP	SP	SP	x	x	x	x
0	0	0	1	0	0	1	0	SP	SP	SP	SP	x	x	x	x
0	0	0	1	0	0	1	1	SP	SP	SP	SP	x	x	x	x
0	0	0	1	0	1	0	0	SP	0	0	SP	x	0	0	x
0	0	0	1	0	1	0	1	SP	0	SP	SP	x	0	x	x
0	0	0	1	0	1	1	0	SP	0	SP	SP	x	0	x	x
0	0	0	1	0	1	1	1	SP	0	SP	SP	x	0	x	x
0	0	0	1	1	0	0	0	SP	SP	0	SP	x	x	0	x
0	0	0	1	1	0	0	1	SP	SP	SP	SP	x	x	x	x
0	0	0	1	1	0	1	0	SP	SP	SP	SP	x	x	x	x
0	0	0	1	1	0	1	1	SP	SP	SP	SP	x	x	x	x
0	0	0	1	1	1	0	0	SP	SP	0	SP	x	x	0	x
0	0	0	1	1	1	0	1	SP	SP	SP	SP	x	x	x	x
0	0	0	1	1	1	1	0	SP	SP	SP	SP	x	x	x	x
0	0	0	1	1	1	1	1	SP	SP	SP	SP	x	x	x	x

Where:

x = any value

SP = any value, but all SP must be same

Recommended Test Method

1) Setup Source DUT and Protocol Analyzer.

2) Configure the Source to output 32kHz, 44.1kHz or 48kHz PCM 2-channel audio.
    3) HDMI Analysis command: ’Full HDMI Compliance‘ or ’Audio Layout’
    4) If HDMI Analysis reports ‘PASS’, then continue, else FAIL
5) If the Source can output >2-channel PCM audio, do the following:
    6) Configure the source to output >2-channel PCM audio
    7) HDMI Analysis command: ’Full HDMI Compliance‘ or ’Audio Layout’
    8) If HDMI Analysis reports ‘PASS’, then PASS, else FAIL

7.7 Source – Interoperability With DVI

Test ID 7-33: Interoperability With DVI

Reference	Requirement
[HDMI: App. C.1] Requirement for DVI Compatibility	"…all HDMI Sources shall be compatible with DVI 1.0 compliant sinks (i.e. "systems" or "hosts") through the use of a similar cable converter."
[HDMI: App. C.2] HDMI Source Requirements	"An HDMI Source, upon power-up, reset or detection of a new sink device, shall assume that the sink device operates under DVI 1.0 limitations. An HDMI Source shall determine if the sink device is an HDMI Sink by following the rule(s) described in Section 8.3.3. Upon detection of an HDMI Sink, the HDMI Source shall follow all of the HDMI Source-related requirements specified in this document."

Test Objective

Verify that Source never outputs a Video Guard Band or Data Island to a device without an HDMI VSDB.

Required Test Method

- Connect Source DUT to Protocol Analyzer acting as a DVI sink (has EDID with no HDMI VSDB nor any other VSDB)
- Configure Source DUT to output any video format timing.
- If any Guard Bands transmitted then FAIL
- If any Data Islands transmitted then FAIL
- Configure Protocol Analyzer with EDID that has an HDMI VSDB of length 5.
- If any Video Data Period has no Guard Bands then FAIL
- If any Video Field has no Data Islands then FAIL
- Configure Protocol Analyzer with EDID that has an HDMI VSDB of any length > 5.
- If any Video Data Period has no Guard Bands then FAIL
- If any Video Field has no Data Islands then FAIL

Recommended Test Method

1) Connect Source DUT to Protocol Analyzer acting as a DVI sink (has EDID with no HDMI VSDB nor any other VSDB)..
2) Configure Protocol Analyzer to perform test "Source: DVI Interoperability"
3) Configure Source DUT to output any video format timing.
4) If Protocol Analyzer reports failure then FAIL
5) Configure Protocol Analyzer with EDID that has an HDMI VSDB of length 5.
6) If Protocol Analyzer reports failure then FAIL
7) Configure Protocol Analyzer with EDID that has an HDMI VSDB of any length > 5.

8) If Protocol Analyzer reports failure then FAIL

7.8 Source – Advanced Features

Test ID 7-34: Deep Color

Reference	Requirement
[HDMI: 5.3.6]	<See reference for details on General Control Packet>
[HDMI: 6.5]	<See reference for details on Deep Color packing and signaling>

Test Objective

Verify that a Deep Color-capable Source DUT outputs correct Deep Color packing and signaling.

Required Test Method

If Source does not support Deep Color (CDF field Source_Deep_Color is "N") then SKIP.

- ❑ Connect Source DUT to a Protocol Analyzer containing an EDID with the following:
  - SVDs for 480p60Hz, 576p50Hz and for 1080i, 720p, and 1080p at 50Hz and 60Hz (and any other formats needing to be tested)
  - Support for any DUT-supported High-Bitrate Audio format (in addition to typical formats)
  - HDMI VSDB of any length > 6 with
    - Supports_AI bit = 1
    - DC_36bit = 1
    - Max_TMDS_Clock = 45 (225MHz)
  - No Colorimetry Data Block
- ❑ For each of the video formats described in CDF field Source_Video_Formats that support any color depths other than 24 bits/pixel, do the following:
- ❑ Operate Source DUT to output that video format at each of the supported color depths (other than 24 bits/pixel).
- ❑ For all of the following, refer to the values listed in Table 7-1 and Table 7-2 for the tested format.
- ❑ For every packet with packet type equal to 0x03 (General Control Packet) verify the following:
  - If either byte HB1, HB2 does not equal 0x00 then FAIL
  - Compare SB0…SB6 of subpacket 0 with SB0…SB6 of subpackets 1, 2 and 3. Likewise, compare subpacket 1 with subpacket 2 and 3 and compare subpacket 2 with subpacket 3.
  - If any subpacket differs from any other then FAIL
  - If SB0 of subpacket 0 does not equal 0x00, 0x01, or 0x10 then FAIL
  - If any byte SB3…SB6 of subpacket 0 does not equal 0x00 then FAIL
  - If SB1 field CD does not indicate 36-bit (0110) then FAIL
  - Track TMDS clock and video format timing across several fields. For each GCP received during that period with CD field non-zero:

- Verify that PP field is updated corrected to indicate the packing phase of the last pixel in the most recent Video Data Period.
- Verify that the TMDS Clock is 40.5MHz (=1.5 * 27MHz). If not, then FAIL.
- If the Default_Phase bit is set, verify that:
  - The first pixel of each Video Data Period has a pixel packing phase of 0 (10P0, 12P0, 16P0).
  - The first pixel following each Video Data Period has a pixel packing phase of 0 (10C0, 12C0, 16C0).
  - The PP bits shall be constant for all GCPs is equal to the last packing phase (10P4, 12P2, 16P1).
  - The first pixel following every transition of HSYNC or VSYNC has a pixel packing phase of 0 (10C0, 12C0, 16C0).
- If any of these conditions is not true, FAIL, “Default_Phase is incorrectly set”.

• Verify that all Video Data Periods, after unpacking (per the pixel packing indicated by the PP field) have a correct length and that all HSYNC and VSYNC positions and lengths are accurate per the values listed in Table 7-1 and Table 7-2. If any values incorrect, then FAIL.

❑ Repeat test for next video format and color depth (other than 24-bit) combination supported by DUT (see CDF field Source_Video_Formats).

Note that the ATC is not required to test Deep Color modes on video formats other than the following: 480p 59.94/60Hz, 576p 50Hz, 1080i 60Hz, 1080i 50Hz and is only required to test 36 bits/pixel mode.

Recommended Test Method — Test ID 7-34: Deep Color

If Source does not support Deep Color (CDF field Source_Deep_Color is “N”) then SKIP.

1) Connect Source DUT to a Deep-Color-capable Protocol Analyzer
2) For each of the video formats described in CDF field Source_Video_Formats that support any color depths other than 24 bits/pixel, do the following:
    3) Operate Source DUT to output that video format at each of the supported color depths (other than 24 bits/pixel):.
        4) With a frequency counter, measure the pixel clock rate and enter this value to the test equipment.
        5) Capture and process data with Protocol Analyzer for Deep Color test.
        6) If Protocol Analyzer reports ‘PASS’, then PASS, else FAIL
    7) Repeat for next supported color depth.
8) Repeat for next video format with >24-bit support.

Note that the ATC is not required to test Deep Color modes on video formats other than the following: 480p 59.94/60Hz, 576p 50Hz, 1080i 60Hz, 1080i 50Hz and is only required to test 36 bits/pixel mode.

Note: Panasonic UITA-1000 cannot be used for this test.

Test ID 7-35: Gamut Metadata Transmission

Reference	Requirement
[HDMI: 5.3.12]	<See reference for details on Gamut Metadata Packet>
[HDMI: Appendix E]	<See reference for details on Gamut Metadata.>

Test Objective

Verify that an xvYCC-capable Source outputs valid Gamut Metadata Packets.

Required Test Method

If Source does not support xvYCC (Source_xvYCC = "N") then SKIP.

- ❑ Connect Source DUT to a Protocol Analyzer containing an EDID with the following:
  - Support for 1080p (in addition to typical formats)
  - HDMI VSDB of any length > 6 with
    - Supports_AI bit = 1
    - DC_36bit = 1
    - Max_TMDS_Clock = 45 (225MHz)
  - Colorimetry Data Block with
    - $xvYCC_{601}$ = 1
    - $xvYCC_{709}$ = 1
    - MD0 = 1
- ❑ Operate Source DUT to output an xvYCC-encoded video signal.
- ❑ Examine all AVI InfoFrames transmitted from Source.
- ❑ If no AVI InfoFrames indicate Extended Colorimetry in fields C1 and C0 (1, 1) then
  - If any video field occurs with a Gamut Metadata packet then FAIL, "While transmitting xvYCC, no AVI indication of xvYCC occurs but Gamut Metdata packet does occur."
- ❑ For every video field containing an AVI InfoFrame with fields C1 and C0 indicating Extended Colorimetry (1, 1)
  - If field EC0 through EC2 is not equal (0 or 1) then FAIL
  - If no Gamut Metadata packet then FAIL, "Missing Gamut Metadata during xvYCC transmission"
  - If Gamut Metadata packet field GBD_profile != 0 then FAIL
  - If Gamut Metadata packet field Packet_Seq != 3 then FAIL
  - If Gamut Metadata packet field Affected_Gamut_Seq_Num - Current_Gamut_Seq_Num != (0 or 1 or -15) then FAIL

Recommended Test Method Test ID 7-35: Gamut Metadata Transmission

If Source does not support xvYCC (CDF field Source_xvYCC) then SKIP.

- ❑ Connect Source DUT to an xvYCC-capable Protocol Analyzer containing an EDID with the following:
- ❑ Operate Source DUT to output an xvYCC-encoded video signal.
- ❑ Capture and process data with Protocol Analyzer for Source xvYCC test.

Note: Panasonic UITA-1000 cannot be used for this test.

Test ID 7-36: High Bitrate Audio

Reference	Requirement
[HDMI: 5.3.11]	<See reference for details on High Bitrate Audio Stream Packet.>
[HDMI: 7.6.2]	<See reference for details on High Bitrate Audio packetization.>

Test Objective

Verify that a High Bitrate Audio-capable source is able to transmit High Bitrate Audio Stream Packets with packet jitter limited to compliant values.

Required Test Method

If Source does not support High Bitrate Audio (CDF field Source_HBRA) then SKIP.

- ❑ Connect Source DUT to an Audio Timing Analyzer containing an EDID with the following:
  - Support for 480p and 576p with 4x pixel repetition (2880xXXXp) (in addition to typical formats)
  - Support for any DUT-supported High-Bitrate Audio format (in addition to typical formats)
  - HDMI VSDB of length = 6 with
    - Supports_AI bit = 1
  - No Colorimetry Data Block
- ❑ Operate Source DUT to output an HBRA signal (e.g. Dolby TrueHD or DTS-HD Master Audio)
- ❑ Monitoring packets:
  - If any packet has type equal to 0x02 (Audio Sample Packet) then FAIL
  - If any packet has type equal to 0x07 (One Bit Audio), 0x08 (DST), 0x0A (GMP) then FAIL
  - If no packet type is equal to 0x09 (High Bitrate Audio Stream Packet) then FAIL
  - For each packet type equal to 0x09:
    - Check following Reserved fields
      - ▪ HB1, all bits
      - ▪ HB2, bits 0 to 3
    - If these reserved fields are not zero then FAIL
- ❑ [Verify High Bitrate Audio Stream packet jitter]

- Measure actual High Bitrate Audio Stream packet rate (Fs_actual).
- n = number of High Bitrate Audio Stream packets over 2 seconds or more (= Ts).
- Calculate Fs_actual using the following equation:
- Fs_actual = n / Ts
  - If High Bitrate Audio Stream packet jitter relative to actual High Bitrate Audio Stream packet rate ever exceeds one video horizontal line period plus a single packet period then FAIL

Recommended Test Method Test ID 7-36: High Bitrate Audio

If Source does not support High Bitrate Audio (CDF field Source_HBRA) then SKIP.

- ❑ Connect Source DUT to a High-Bitrate Audio-capable Audio Timing Analyzer:
- ❑ Operate Source DUT to output a High-Bitrate Audio-encoded video signal.
- ❑ Capture and process data with Audio Timing Analyzer for Source HBRA test.

Note: Panasonic UITA-1000 cannot be used for this test.

Test ID 7-37: One Bit Audio

Reference	Requirement
[HDMI: 5.3.9]	<See reference for details on One Bit Audio Sample Packet.>
[HDMI: 7.9]	<See reference for details on One Bit Audio.>

Test Objective

Verify that a One Bit Audio-capable source is able to transmit One Bit Audio Packets in a compliant manner.

Required Test Method

If Source does not support One Bit Audio (CDF field Source_One_Bit_Audio) then SKIP.

- ❑ Connect Source DUT to an Audio Timing Analyzer containing an EDID with the following:
  - Support for 480p and 576p with 2x pixel repetition (1440xXXXp) (in addition to typical formats)
  - Short Audio Descriptor for One Bit Audio format with 6-channels and 44.1kHz sample rate.
  - HDMI VSDB of length = 6 with
    - Supports_AI bit = 1
  - No Colorimetry Data Block
- ❑ Operate Source DUT to output One Bit Audio on the HDMI output

Monitor packets:

- ❑ If any packet has type equal to 0x02 (Audio Sample Packet) then FAIL
- ❑ If any packet has type equal to 0x08 (DST), 0x09 (HBRA), 0x0A (GMP) then FAIL
- ❑ If no packet type is equal to 0x07 (One Bit Audio Sample Packet) then FAIL
- ❑ For each packet type equal to 0x07:
  - Check following Reserved fields
    - HB1, bits 5 to 7
    - HB2, bits 5 to 7
  - If these reserved fields are not zero then FAIL

- ❑ [Check Audio InfoFrame]
- ❑ Examine the placement of the Audio InfoFrame Packet
- ❑ If Audio InfoFrame Packet (0x84) is not detected at least once per two video fields then FAIL
- ❑ [Check Packet Header]
- ❑ If Packet Header has the following contents
    - HB0: 0x84 (InfoFrame Type Code)
    - HB1: 0x01
    - HB2: 0x0A (InfoFrame_length, reserved)
  - Then continue else then FAIL
- ❑ [Check PB1 to PB5]
  - If the value of Audio Coding Type (CT3 ~ CT0) is not zero then FAIL
  - If the value of PB1 bit 3 is not zero then FAIL.
  - If the value of the most significant three bits of PB2 is not zero then FAIL
  - If the value of Sampling Frequency (SF2 ~ SF0) is not 0b010 then FAIL
  - If the value of Sample Size (SS1 ~ SS0) is not zero then FAIL
- ❑ [Check for illegal CA]
  - If CA >= 0x20 then FAIL
- ❑ [Check for valid Combination of (CA7 ~ CA0) and (CC2 ~ CC0)]
  - If indicator in Audio sample packet indicates layout 0
    - If CA!= 0x00 then FAIL
    - If CC!= 0,0,0 and CC != 0,0,1 then FAIL
  - else [layout 1]
    - FAIL if all of the following statements are false:
      CC== 0,0,0 and CA is in set { 0x01, 0x02, 0x03,…, or 0x1F }
      CC== 0,1,0 and CA is in set { 0x01, 0x02 or 0x04 }

CC== 0,1,1 and CA is in set { 0x03, 0x05, 0x06, 0x08 or 0x14}

CC== 1,0,0 and CA is in set { 0x07, 0x09, 0x0A, 0x0C, 0x15, 0x16, or 0x18 }

CC== 1,0,1 and CA is in set { 0x0B, 0x0D, 0x0E, 0x10, 0x17, 0x19, 0x1A , or 0x1C }

CC== 1,1,0 and CA is in set { 0x0F, 0x11, 0x12, 0x1B, 0x1D or 0x1E }

CC== 1,1,1 and CA is in set { 0x13 or 0x1F }

- [If LSV is non-zero, then only 2-channels allowed (downmix)]
  - If LSV != 0x0 and CA != 0x00 then FAIL
- [Check for valid combination of DM_INH and CA]
  - If DM_INH ==1 and CA == 0x00 then FAIL
- If value of the least significant three bits of PB5 is zero then continue else then FAIL
- If value of PB6 through PB27 is 0x00. then continue else then FAIL
- [Verify checksum]
- Do a byte wide sum of HB0,HB1,HB2, PB0, PB1, PB2,…, PB10.
- If sum == 0x00 then PASS else then FAIL
- [Verify One Bit Audio Sample subpacket jitter]
  - Measure actual One Bit Audio Sample subpacket rate (Fs_actual).
  - n = number of One Bit Audio Sample subpackets over 2 seconds or more (= Ts).
  - Calculate Fs_actual using the following equation:
  - Fs_actual = n / Ts
    - If One Bit Audio Sample subpacket jitter, relative to actual One Bit Audio Sample subpacket rate, ever exceeds one video horizontal line period plus a single subpacket period then FAIL

Recommended Test Method — Test ID 7-37: One Bit Audio

If Source does not support One Bit Audio (CDF field Source_One_Bit_Audio) then SKIP.

- Connect Source DUT to an Audio Timing Analyzer with an appropriate EDID.
- Operate Source DUT to output One Bit Audio on the HDMI output
- Capture and process data with Audio Timing Analyzer for Source One Bit Audio test.

Note: Panasonic UITA-1000 cannot be used for this test.

8 Tests – Sink

8.1 Sink Products Overview

8.1.1 Television and Other Display Products

Display products are defined to “adequately support” a particular video format if they display that format, legibly and correctly placed (e.g. centered) horizontally and vertically in the expected aspect ratio and over/underscan amount.

For overscanned formats, horizontally and vertically, at least some portion of the active portion of the image must not be visible due to border obstruction or clipping. For underscanned images, 100% of the active portion must be visible.

8.1.2 Audio Rendering Products

Displays, audio amplifiers or other products designed to “render” the audio (convert to actual sound) are defined to “adequately support” a particular audio format if they reproduce the audio at approximately the same level of fidelity as any other audio input on that device.

8.1.3 Non-Display Devices

If the Sink product has no display but does have an analog or other video output that can be attached to a display thereby providing the same function, this output/display may be used to determine support of the received HDMI signal.

8.2 Sink – EDID / E-DDC

Test ID 8-1: EDID Readable

Reference	Requirement
[HDMI: 8.3] E-EDID Data Structure	"All Sinks shall contain a CEA-861-D compliant E-EDID data structure accessible through the DDC." <See reference for additional details.>

Test Objective

Verify that the entire EDID can be read.

Required Test Method

- ❑ Connect an EDID Reader/Analyzer to the Sink DUT.
- ❑ Power ON the Sink DUT.
- ❑ Apply +5.0V to +5V Power pin.
- ❑ Operate the EDID Reader/Analyzer to perform the following:
  - Read Block 0 (128 bytes) of the Sink's EDID.
  - EXTENSION_COUNT = Extension Flag (block 0, byte 0x7E)
  - If EXTENSION_COUNT == 0x00 then:
    - FAIL then "Missing EDID Extension"
  - If EXTENSION_COUNT >= 0x01 then:
    - Use any sequence of legal DDC reads to read the second 128 bytes of the EDID.
    - If any read NACKs inappropriately then FAIL, "DDC NACK"
  - If EXTENSION_COUNT > 0x01 then:
    - Use any sequence of legal segment register-based E-DDC reads to read block 2 through block EXTENSION_COUNT+1
    - If any read NACKs inappropriately then FAIL, "E-DDC NACK"
- ❑ Store the EDID image for analysis on subsequent Sink tests.
- ❑ Power OFF the Sink DUT, continue applying +5.0V to +5V Power
- ❑ If HPD is asserted by Sink perform the following:
  - Read the entire EDID (as above)
  - If EDID image read error then FAIL
  - Compare to previously stored EDID image
  - If EDID images do not match then FAIL

Recommended Test Method Test ID 8-1: EDID Readable

Note that the Recommended Test Equipment (Quantum Data 882CA) can be used to perform all EDID-checking tests simultaneously. This includes all tests in section 8.2 and several tests in 8.5.

1) Connect Sink DUT to Quantum Data 882CA and perform EDID analysis.
2) If any errors are reported during EDID read then FAIL, <error comment>
3) Else, then PASS

Test ID 8-2: EDID VESA Structure

Reference	Requirement
[HDMI: 8.3] E-EDID Data Structure	"The first 128 bytes of the E-EDID shall contain an EDID 1.3 structure. The contents of this structure shall also meet the requirements of CEA-861-D." <See reference for additional details.>
[861-D: 7] EDID Data Structure	<See reference for details.>

Test Objective

Verify that the data in the base EDID 1.3 block and basic EDID Extension handling is correct and meets all aspects of the relevant specifications.

Required Test Method

Use the EDID Reader/Analyzer to analyze the EDID image that was captured in the "EDID Readable" above, as follows:

- ❑ EXTENSION_COUNT = Extension Flag (block 0, byte 0x7E)
- ❑ If EXTENSION_COUNT == 1
  - BLOCK_COUNT = 2
- ❑ Else, (EXTENSION_COUNT > 1)
  - BLOCK_COUNT = EXTENSION_COUNT+1
- ❑ Perform the following tests on Block 0:
  - [Verify valid EDID Block 0 header]
    - Examine block 0: bytes 0x00 through 0x07. Values shall be 0x00, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0x00.
    - If any values different then FAIL, "Incorrect Block 0 header"
  - [Verify EDID Version]
    - Examine bytes 0x12 and 0x13. Values shall be 0x01, 03h.
    - If any values different then FAIL, "Incorrect EDID version"
  - [Verify Video Information Byte] (This indicates that the interface is digital.)
    - Examine byte 0x14. Value shall be either 0x80 or 0x81.

  - If value is not 0x80 or 0x81 then FAIL, “Incorrect Video Information Byte”
- [Verify Preferred Timing bit is set]
  - If byte 0x18, bit # 1 != 1then FAIL, “Incorrect Preferred Timing bit”
- [Verify that Detailed Timing Description (DTD) #1 contains a timing descriptor]
  - Examine 16-bits at bytes 0x36 and 0x37. (Pixel clock / 10,000). Combined word shall be non-zero.
  - If value is 0x0000 then FAIL, “Missing Preferred Timing descriptor”
- [Verify that DTD #1-#4 contains one Monitor Range Limits descriptor and one Monitor Name descriptor]. [EDID 1.3: 3.10.3]
  - Examine 4 byte values at locations 0x36…0x39, 0x48…0x4B, 0x5A…0x5D and 0x6C…0x6F, looking for following values:
    - 0x00, 0x00, 0x00, 0xFD [= Monitor Range Limits header]
    - 0x00, 0x00, 0x00, 0xFC [= Monitor Name header]
  - If Monitor Range Limits header not present in examined bytes then FAIL, “Missing Monitor Range Limits”
  - If Monitor Name header not present in examined bytes then FAIL, “Missing Monitor Name”
  - If monitor name terminating byte != 0x0A then FAIL.
  - If monitor name length is less than 13 bytes and padding bytes (following 0x0A) != 0x20 then FAIL.
- [Verify that DTD #2, #3, or #4 appear in correct order]
  - If bytes 0x6C…0x6D != 0 or 0x5A…0x5B != 0 then FAIL, “DTD follows Monitor Descriptor”
  - If bytes 0x48…0x49 != 0 :
    - If bytes 0x36…0x37 == 0 then FAIL, “DTD follows Monitor Descriptor”

❑ [Verify that Block 1 contains either a CEA Timing Extension or a valid block map]

- If EXTENSION_COUNT == 1
  - If block 1: byte 0 != 0x02 then FAIL, “Missing CEA Extension in block 1”
- Else, (EXTENSION_COUNT > 1)
  - If block 1: byte 0 != 0xF0 then FAIL, “Missing Block Map in block 1”
  - If block 2: byte 0 != 0x02 then FAIL, “Missing CEA Extension in block 2”
  - For every byte <N> from byte 1 through byte EXTENSION_COUNT-1:
    - If block 1, byte N != block N+1, byte 0 then FAIL, “Block Map/Extension mis-match”
  - For every byte <N> from byte EXTENSION_COUNT through byte 0x7E (126):
    - If block 1, byte N != 0 then FAIL, “Block Map byte <N> incorrect”

❑ Perform the following for each block <N> in the EDID, from block 0 to block BLOCK_COUNT:

- [Verify Block Checksum]
  - Sum all of the bytes in block from byte 0x00 to 0x7F. Result is the lower 8 bits of the sum. Sum result shall be 0x00.

- If checksum != 0x00 then FAIL, “Incorrect checksum, block <N>”

Recommended Test Method Test ID 8-2: EDID VESA Structure

Note that the Recommended Test Equipment (Quantum Data 882CA) can be used to perform all EDID-checking tests simultaneously. This includes all tests in section 8.2 and several tests in 8.5.

1) Connect Sink DUT to Quantum Data 882CA and perform EDID analysis.
2) If any errors are reported then FAIL, <error comment>
3) Else, then PASS

Test ID 8-3: CEA Timing Extension Structure

Reference	Requirement
[HDMI: 8.3.1] EDID Timing Extension	“The first E-EDID ‘extension’ shall contain a CEA EDID Timing Extension version 3, defined in CEA-861-D section 7.5. Additional CEA EDID Timing Extensions may also be present.” <See reference for additional details.>

Test Objective

Verify that the data in any CEA Timing Extension present in EDID is formatted properly and meets all aspects of the relevant specifications. [Note: The accuracy of the video and audio-related EDID information is tested in the Video and Audio test sections.]

Required Test Method

Use the EDID Reader/Analyzer to analyze the EDID image that was captured in the “EDID Readable” above, as follows:

- ❑ EXTENSION_COUNT = Extension Flag (block 0, byte 0x7E)
- ❑ If EXTENSION_COUNT == 1
  - BLOCK_COUNT = 2
- ❑ Else, (EXTENSION_COUNT > 1)
  - BLOCK_COUNT = EXTENSION_COUNT+1

Perform following tests for each CEA Extension found, including the first:

- ❑ [Verify Revision Number]
  - Check byte #1 (Revision Number) of this CEA Timing Extension
  - If byte #1 != 3 then FAIL, “Incorrect CEA Extension version”
- ❑ [Verify Basic Audio requirement]
  - If 1st CEA Timing Extension byte #3, bit #6 is 0 and CDF field Sink_Basic_Audio =”Y”then FAIL, “Basic Audio claimed in CDF but not indicated in EDID.”
  - If 1st CEA Timing Extension byte #3, bit #6 is 1 and CDF field Sink_Basic_Audio =”N”then FAIL, “No Basic Audio claimed in CDF but is indicated in EDID.”
- ❑ [Verify data structure of CEA Extension] Scan through all Data Blocks checking the following:

- If Data Block Tag Code (bits #7…5 of Data Block's 1st byte) has a value of 0, or 6 then FAIL, "Illegal Data Block type"
- If Tag Code == 1 [Audio Data Block]
  - If 1st CEA Timing Extension byte #3, bit #6 is 0 then FAIL, "No Basic Audio but Audio Data Block found"
  - If Data Block Length (bits #4…0 of 1st byte) isn't a multiple of 3 (3, 6, 9…) then FAIL, "Illegal Audio Block length"
  - For each Short Audio Descriptor (3 bytes long) in Audio Data Block
    - If 1st byte, bit #7==1 or 2nd byte, bit #7==1 then FAIL, "Short Audio Descr. Rsvd bits set"
    - If Audio Format Code (1st byte, bits #6…3) == 0001 (PCM)
      - If 3rd byte, bits #7…3 != 0 then FAIL, "Short Audio Descr, Rsvd bits set"
      - If 2nd byte, bits #0, 1, 2 (32, 44.1, 48kHz) do not equal 1, 1, 1 then FAIL, "PCM descriptor missing Basic Audio frequencies".
      - If 1st byte, bits #2…0 (Max Num channels) > 1 (more than 2 channels) then:
        - Determine if a Speaker Allocation Data Block is present. [861-D: 7.5.3]
        - If no Speaker Allocation Data Block is present then FAIL.
- If Tag Code == 4 [Speaker Allocation Data Block]
    - If Data Block Length (bits #4…0 of 1st byte) != 3 then FAIL, "Illegal Speaker Alloc Block length"
    - If 1st byte of Speaker Allocation Data Block Payload, bit #7==1 then FAIL, "Speaker Alloc Descr. rsvd bits set"
    - If 2nd byte!=0 or 3rd byte!=0 then FAIL, "Speaker Alloc. rsvd bytes set"
    - Verify that no more than 1 Speaker Allocation Data Block is present and if present, is in 1st CEA Extension
    - If more than one Speaker Alloc. Data Block found then FAIL, "More than one Speaker Alloc Block"
- If Tag Code == 7 [Extended Tag Data Blocks]
  - If Extended Tag Code (1st byte following Tag Code byte) == 0 (Video Capability Data Block)
    - If data block byte #3 (1st byte following Extended Tag Code byte) bit 7 is not equal 0 then FAIL, "Video Capability Data Block, bit F37 is 1".
    - [Check S_CE bits]
    - If data block byte #3 bits 1 and 0 are equal 00 then FAIL, "Video Capability Data Block indicates no CE formats supported."
    - [Check S_IT bits]
    - If data block byte #3 bits 2 and 3 are equal 00 then FAIL, "Video Capability Data Block indicates no VGA or other IT formats supported."
  - If Extended Tag Code (1st byte following Tag Code byte) == 5 (Colorimetry Data Block)

- If data block byte #3 (1st byte following Extended Tag Code byte) bits 0 and 1 are not equal 00 then:
    - If data block byte #4 bit 0 !=1 then FAIL, "Metadata P0 required if xvYCC supported."
- If data block byte #3 (1st byte following Extended Tag Code byte) bits 0 and 1 are equal 00 then:
    - If data block byte #4 any bits 0…7 are set then FAIL, "Illegal gamut metadata indication"
- If data block byte #3 any bits 2…7 are set then FAIL, "Illegal extended colorimetry indicated."
- If data block byte #4 any bits 1…7 are set then FAIL, "Illegal gamut metadata indication"

- If location of next Data Block (current location + 1 + length) < d, continue scanning of Data Blocks
- If location of next Data Block > d then FAIL, "d points into Data Block"
- If location of next Data Block == d, stop scanning and continue tests

❑ Perform the following for the 1st CEA Timing Extension in EDID:

- [Verify presence of HDMI Vendor-Specific Data block in first CEA Extension]
    - Find first Data block with the values 0b011xxxxx, 0x03, 0x0C, 0x00 in the first 4 bytes (where 'xxxxx' can be any 5 bit value).
    - If no Data Block in 1st CEA Extensions has signature above then FAIL, "Missing HDMI VSDB"
- For following, VSDB_length = lower 5 bits of byte 0 of HDMI VSDB
- [HDMI VSDB: Verify length field of HDMI VSDB]
    - If VSDB_length < 5 then FAIL, "HDMI VSDB too short"
- [HDMI VSDB: Verify Physical Address in HDMI VSDB is P.0.0.0 for CEC root device, where P is equal to the number of the port, starting at 1 for the first port]
    - If CDF field HDMI_output_count == 0 and CDF field CEC_root_device = "N" then FAIL
    - If CDF field HDMI_output_count == 0 or CDF field CEC_root_device = "Y" or if testing Sink function as part of Repeater Test ID 9-4 then:
        - Set P to the port number of the tested port. If the DUT only has a single HDMI port, P=1 (physical address = 1.0.0.0). If two ports, P=1 for first port, P=2 for second port etc.
        - If bytes 4 and 5 of HDMI VSDB are not 0xP0 and 0x00 (i.e. Source physical address = 1.0.0.0 or 2.0.0.0, or…) then FAIL, "Bad Physical Address"
- [HDMI VSDB: Verify Extension Fields]
    - If CDF field Sink_Supports_AI is "Y"
        - If HDMI VSDB byte 0 <= 0x65 or HDMI VSDB Supports_AI bit is 0 then FAIL, "Incorrect Supports_AI field"
    - Else (if the CDF field Sink_Supports_AI is "N")

        - If HDMI VSDB byte 0 > 0x65 and HDMI VSDB Supports_AI bit is 1 then FAIL, “Incorrect Supports_AI field”
- If VSDB_length >= 6 then
    - If byte 6, bits 2, 1 do not equal 0 then FAIL
    - If byte 6, bit 3 equals 1 and byte 6, bits 4, 5 and 6 all equal 0 then FAIL, “DC_Y444 set but no Deep Color depth indicated.”
    - If byte 6, bits 4 or 6 (DC_48bit or DC_30bit) equals 1 and bit 5 (DC_36bit) equals 0 then FAIL, “DC_30bit or DC_48bit supported without default DC_36bit supported.”
    - If VSDB_length = 6 then
        - If byte 6, bits 4, 5, or 6 (DC_48…30bit) equals 1 then FAIL, “Max_TMDS_Clock field not present despite Deep Color support indicated.”
        - If byte 6, bit 0 (DVI_Dual) equals 1 then FAIL, “Max_TMDS_Clock field not present despite DVI_Dual support indicated.”
- If VSDB_length >= 7 then
    - If byte 7 equals 0 then
        - If byte 6, bits 4, 5, or 6 (DC_48…30bit) equals 1 then FAIL, “Max_TMDS_Clock field zero despite Deep Color support indicated.”
        - If byte 6, bit 0 (DVI_Dual) equals 1 then FAIL, “Max_TMDS_Clock field zero despite DVI_Dual support indicated.”
- If VSDB_length >= 8 then
    - If byte 8 does not equal 0x00, 0x40, 0x80, 0xC0 then FAIL
    - If byte 8 equals 0x40 (Latency_Fields_Present=0, I_Latency_Fields_Present=1) then FAIL, “I_Latency_Fields_Present cannot be set unless Latency_Fields_Present is set.”
    - If byte 8 equals 0x80 (Latency_Fields_Present=1, I_Latency_Fields_Present=0) then
        - If VSDB_length < 10 then FAIL, “Latency_Fields_Present is set but VSDB is too short.”
    - If byte 8 equals 0xC0 (Latency_Fields_Present=1, I_Latency_Fields_Present=1) then
        - If VSDB_length < 12 then FAIL, “Latency_Fields_Present and I_Latency_Fields_Present are set but VSDB is too short.”

- [HDMI VSDB: Verify Reserved bytes at end]
    - If VSDB_length >= 9 then
        - Examine HDMI VSDB bytes M through VSDB_length, where M is 9, 11 or 13 depending upon the values of Latency_Fields_Present and I_Latency_Fields_Present.
        - If any of these bytes are non-zero then FAIL, “Non-zero Reserved Extension Fields”
- [HDMI VSDB: Verify that no HDMI VSDB exists in this or subsequent data block]

- Search for a 2nd Data block with the values 0b011xxxxx, 0x03, 0x0C, 0x00 in the first 4 bytes anywhere in any CEA Extension.
- If any other Data Block has signature above then FAIL, “Extra HDMI VSDB”

❑ Perform the following for all CEA Extension except the 1st CEA Extension in EDID:

- [Verify consistency of byte 3 (number of native timings plus flags) among all CEA Timing Extensions]
    - Compare byte #3 of this CEA Timing Extension with byte #3 of first CEA Timing Extension.
    - If byte 3 != byte 3 of 1st CEA Extension then FAIL, “Unmatched byte 3 in CEA Extension”
- [Verify that no HDMI VSDB exists in subsequent Extension]
    - Search for a Data block with the values 0b011xxxxx, 0x03, 0x0C, 0x00 in the first 4 bytes.
    - If any Data Block in this CEA Extension has signature above then FAIL, “Extra HDMI VSDB”

❑ [Verify that number of native DTDs is ≤ number of DTDs in EDID]

- If lower 4 bits of byte 3 of 1st CEA Extension > number of DTDs in EDID then FAIL, “Native DTD count larger than number of DTDs”

Recommended Test Method Test ID 8-3: CEA Timing Extension Structure

Note that the Recommended Test Equipment (Quantum Data 882CA) can be used to perform all EDID-checking tests simultaneously. This includes all tests in section 8.2 and several tests in 8.5.

1) Connect Sink DUT to Quantum Data 882CA and perform EDID analysis.
2) If any errors are reported then FAIL, <error comment>
3) Else, then PASS

8.3 Sink – Electrical

Test ID 8-4: TMDS – Termination Voltage

Reference	Requirement
[HDMI: Table 4-17 Sink DC Characteristics When Source Disabled or Disconnected at TP2	With Source disabled or disconnected, the differential voltage level on each TMDS pair must be AV_{CC}±10mV.

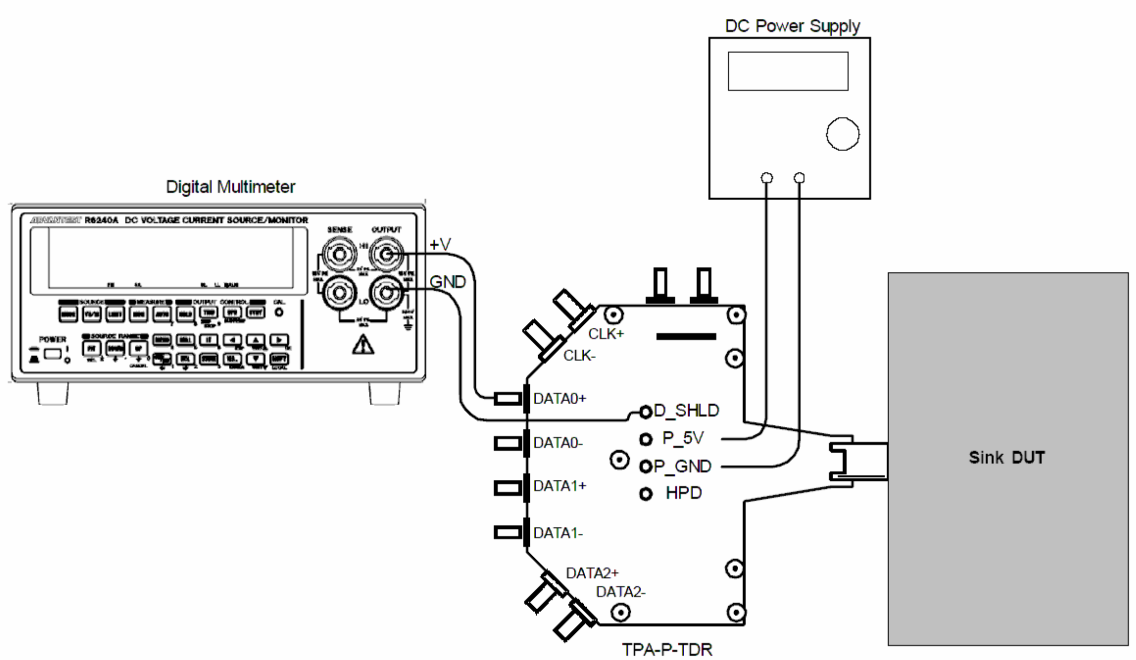
Test Objective

Confirm that the differential voltage level on each TMDS pair is within specified limits.

Required Test Method

- Connect TPA-P to HDMI input connector of Sink DUT.
- Turn on the power to the Sink DUT and verify that the HDMI input is active (e.g. correct input is selected, etc.).
- Connect the multi-meter probes to the TMDS_DATA0+ and TMDS_DATA0_Shield.
- V_{TERM} = measured voltage level
- If (V_{TERM} < 3.125V) OR (V_{TERM} > 3.475V) then FAIL.
- Repeat for all remaining TMDS_DATA and TMDS_CLOCK, + and - signals, measuring between the signal and its shield.

Recommended Test Method Test ID 8-4: TMDS – Termination Voltage



Setup 37. Test ID 8-4: TMDS – Termination Voltage

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	DC Power Supply	<See reference>	4.2.1.15	1
3	TPA-P Fixture	Any TPA-P with access to +5V_Power, DDC/CEC Ground and all TMDS signals.	4.2.1.1.6	1

1) Connect TPA-P to HDMI input connector of Sink DUT.
2) Verify that TPA-P has no termination resistors attached.
3) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) on TPA-P
4) Turn on the power to the Sink DUT and verify that the HDMI input is active (e.g. correct input is selected, etc.).
5) Connect the multi-meter probes to the TMDS_DATA0+ and TMDS_DATA0_Shield.
6) V_{TERM} = measured voltage level
7) If (V_{TERM} < 3.125V) OR (V_{TERM} > 3.475V) then FAIL.
8) Repeat for all remaining TMDS_DATA and TMDS_CLOCK, + and - signals, measuring between the signal and its shield.

Test ID 8-5: TMDS – Min/Max Differential Swing Tolerance

Reference	Requirement
[HDMI: Table 4-19] Sink AC Characteristics at TP2	Minimum differential sensitivity (peak-to-peak) is 150mV.

Test Objective

Confirm that the Sink properly supports TMDS differential voltages at minimum levels.

Required Test Method

1) Connect TMDS Signal Generator to Sink DUT.
2) Turn on the power to the Sink DUT and verify that the HDMI input is active.
3) Connect and configure DC Power Supply to drive +5V between +5V Power and DDC/CEC Ground on TPA-P.
4) Configure the TMDS Signal Generator to output any video format at the highest supported frequency with a pattern consisting of a repeating RGB gray ramp (Ex. 0, 1, 2…254, 255, 0, 1, 2…) during each video period.
5) Add TTCs to the outputs, as needed, to create a TMDS rise/fall time between 75pS and 110pS.
6) Adjust the common mode voltage (V_{ICM}) to:
   - 2.9V if the Sink supports TMDS clock rates >165MHz.

- 3.0V if the Sink supports only TMDS clock rates <=165MHz.

[Search for and record the minimum differential swing voltage that the Sink DUT supports without error]:

7) Set common mode voltage as required for this test case

8) Starting with a differential swing of 170mV or more, gradually reduce the swing on all TMDS pairs until the Sink DUT fails to support the signal without errors.

9) Record the minimum differential swing voltage that the Sink DUT supports without error ($V_{DIFF\_MIN\_DC}$).

10) If $V_{DIFF\_MIN\_DC}$ >= 150mV then FAIL, "Min diff swing unsupported at Vicm1 range".

11) Return swing to 170mV and set V_{ICM} = 3.3V. Repeat search for min supported differential swing ($V_{DIFF\_MIN\_AC}$).

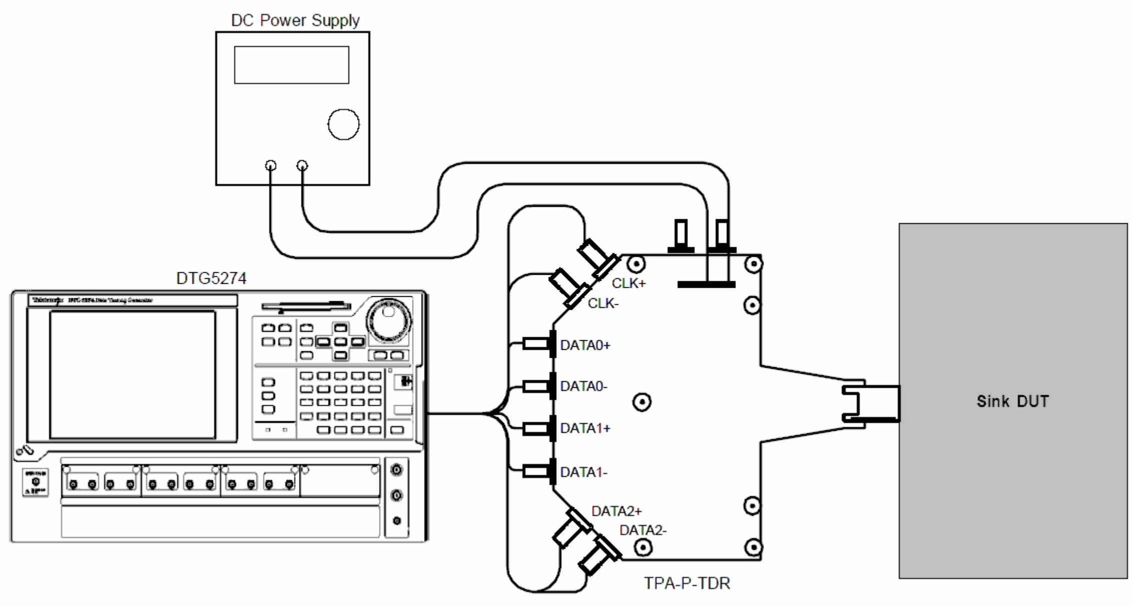
12) If $V_{DIFF\_MIN\_AC}$ >= 150mV then FAIL, "Min diff swing unsupported at Vicm2 range".

13) Change the differential swing to 1.2V (600mV/single-ended signal = max swing) while maintaining V_{ICM} = 3.3V.

14) Verify that the DUT continues to support the signal without errors.

15) If DUT fails to support the signal then FAIL, "Max diff swing unsupported at Vicm2 range".

Recommended Test Method – Tektronix



Setup 38. Test ID 8-5: TMDS – Min/Max Differential Swing Tolerance – Tektronix

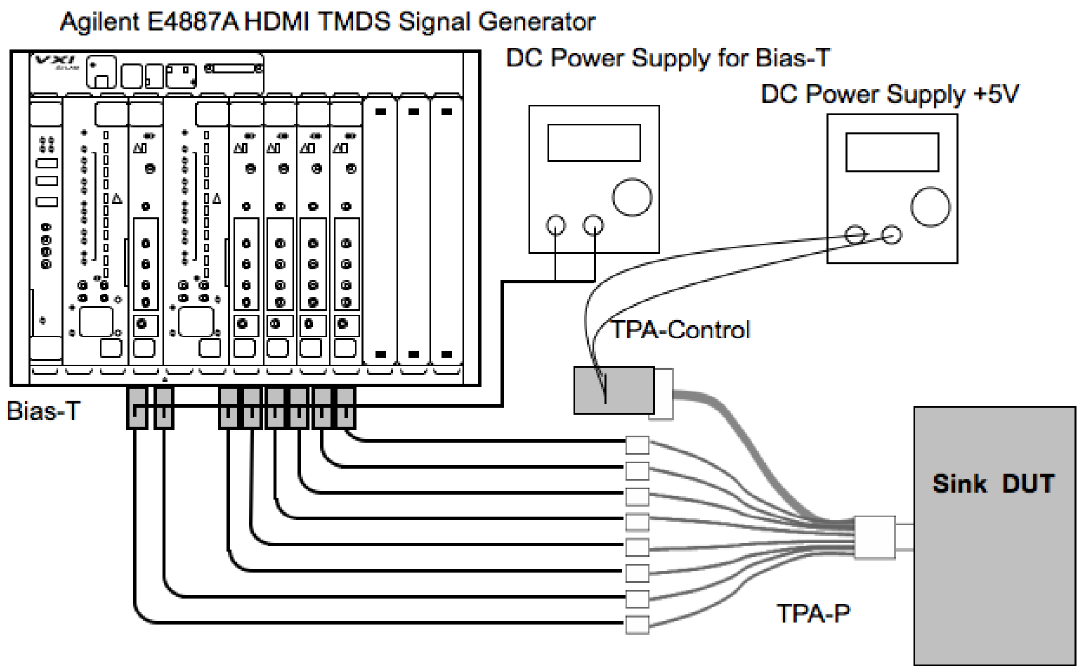
No.	Description	Recommended TE	Reference	Qty.
1	TMDS Signal Generator	Tektronix DTG5274 or Tektronix DTG5334	4.2.1.9	1
2	DC Power Supply	<See reference>	4.2.1.15	1
3	SMA Cables	<See reference>	4.2.1.7	8
4	TPA-P-SMA Fixture	Tektronix TPA-P-TDR or EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.6	1

1) Connect DTG to TPA-P using eight 2‘ SMA cables.
   - Module A, Channel 1+, 1-: connect to TMDS_CLOCK +,–
   - Module A, Channel 2+, 2-: No connect
   - Module B, Channel 1+, 1-: connect to TMDS_DATA0+,– (DATA0_P, DATA0_N)
   - Module B, Channel 2+, 2-: connect to TMDS_DATA1+,–
   - Module C, Channel 1+, 1-: connect to TMDS_DATA2+,–
   - Module C, Channel 2+, 2-: No connect
2) Connect TPA-P to HDMI input connector of Sink DUT.
3) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) on the TPA-P.

Perform the Required Test Method with this setup. For adjustments required during the test sequence, do the following:

- ❑ To adjust the differential swing: V_{DIFF_SWING}
  - Use the Tektronix DTG “Level” window and select “Amplitude and Offset” mode. In this mode, “Amplitude” should be set to half of the differential swing, for instance, 0.085Vpp to correspond to a 170mV differential swing.
- ❑ To adjust the common mode voltage: V_{ICM}
  - Use the Tektronix DTG “Level” window and select “Amplitude and Offset” mode.

Recommended Test Method – Agilent



Setup 39. Test ID 8-5: TMDS – Min/Max Differential Swing Tolerance - Agilent

No.	Description	Recommended TE	Reference	Qty.
1	TMDS Signal Generator	Agilent E4887A	4.2.1.9	1
2	Bias-T	<See reference>	4.2.1.9	8
3	DC Power Supply	<See reference>	4.2.1.15	2
4	SMA Cables	Agilent N4871A	4.2.1.7	8
5	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
6	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Connect TMDS Signal Generator to TPA-P using eight Agilent N4871A SMA cables.

- Using Bias-Tees on each Agilent E4887A output, connect Agilent E4887A as follows:
  - Clockgroup A, Channel 1+, 1–: connect to TMDS_CLOCK+, –
  - Clockgroup B Channel 1+, 1–: connect to TMDS_DATA0+, – (“DATA0_P”, “DATA0_N”)
  - Clockgroup B, Channel 2+, 2–: connect to TMDS_DATA1+, –
  - Clockgroup B, Channel 3+, 3–: connect to TMDS_DATA2+, –
  - Clockgroup B Channel 4+, 4–: No connect
- Add “60psec” TTC to each output.

2) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) through TPA-Control (N1080A-H03).

Perform the Required Test Method with this setup. For adjustments required during the test sequence, do the following:

- To adjust the differential swing: V_{DIFF_SWING}
  - Set the single ended signal levels to half of the differential swing, for instance, 85mV to correspond to a 170mV differential swing.
- To adjust the common mode voltage: V_{ICM}
  - Set the V_{ICM} by adjusting the power supply to the Agilent E4887A -connected Bias-Tees. V_{ICM} = (3.3V + Bias-T voltage)/2:
    - V_{ICM} = 2.9V : set Bias-T voltage = 2.5V
    - V_{ICM} = 3.0V : set Bias-T voltage = 2.7V
    - V_{ICM} = 3.3V : set Bias-T voltage = 3.3V

Test ID 8-6: TMDS – Intra-Pair Skew

Reference	Requirement
[HDMI: Table 4-19] Sink AC Characteristics at TP2	Allowable Intra-Pair Skew at Sink Connector is 0.4*T_{BIT}

Test Objective

Confirm that the maximum allowed timing skew within each TMDS pair is supported by the Sink DUT.

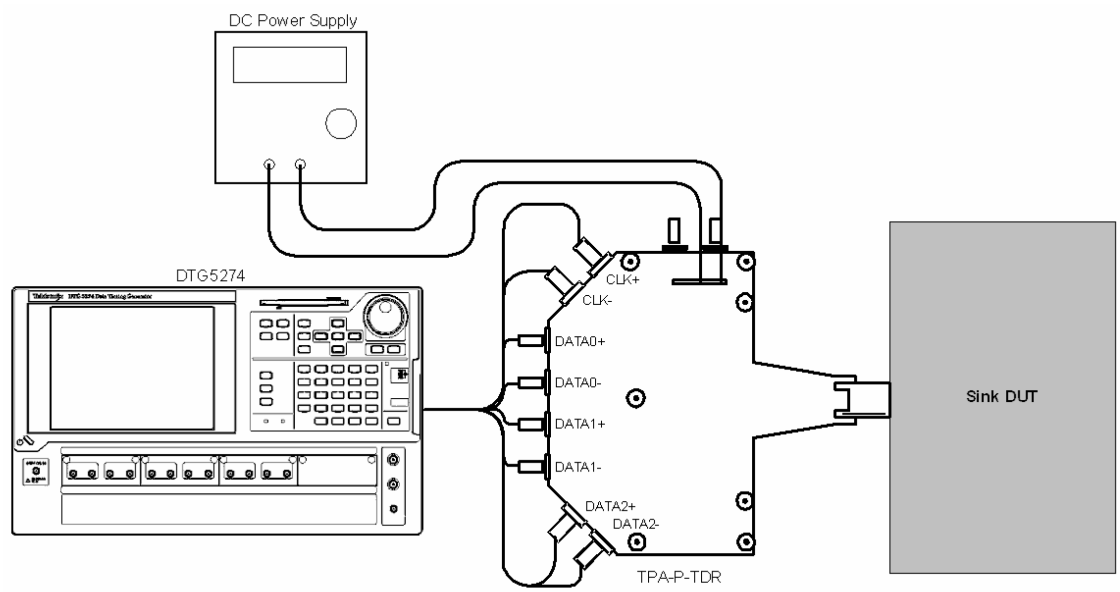
Required Test Method

- Configure the TMDS Signal Generator to output any Sink-supported video format and pixel size with the maximum Sink-supported TMDS clock frequency.
- For all TMDS signals, set the common mode voltage (V_{ICM}) to 3.05V and the single-ended swing to 500mV. Add TTCs to the outputs, as needed, to create a TMDS rise/fall time between 75pS and 110pS.
- Connect TPA-P to HDMI input connector of Sink DUT.
- For each of the TMDS clock and data pairs acting as the tested pair:
  - Configure the TMDS Signal Generator to support adding skew between + and – signals of the tested pair.
  - Increase the skew (Differential Timing Offset) by steps of less than or equal to 0.1*T_{BIT}, until the Sink DUT outputs errors or until reaching either 0.6*T_{BIT} or 1nsec.
  - If errors seen on DUT:
    - Reduce the skew one step, so that Sink DUT outputs no errors.
    - If TMDS clock frequency is <=222.75MHz:
      - If intra-pair skew < 0.4*T_{BIT}, then FAIL.
    - Else (TMDS clock frequency is >222.75MHz):
      - If intra-pair skew < 112psecs + 0.15*T_{BIT}, then FAIL.

- Repeat the test but add the skew in the opposite direction

❑ Repeat the test for each of the remaining untested pairs.

Recommended Test Method – Tektronix Test ID 8-6: TMDS – Intra-Pair Skew



Setup 40. Test ID 8-6: TMDS – Intra-Pair Skew

No.	Description	Recommended TE	Reference	Qty.
1	TMDS Signal Generator	Tektronix DTG5274 or Tektronix DTG5334	4.2.1.9	1
2	DC Power Supply	<See reference>	4.2.1.15	1
3	SMA Cables	<See reference>	4.2.1.7	8
4	TPA-P-SMA Fixture	Tektronix TPA-P-TDR or EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.6	1

1) Setup and configure the Tektronix DTG and DUT:
   - Connect the DTG to the TPA-P using eight 2’ SMA cables:
     - Module A, Channel 1+, 1-: No connect
     - Module A, Channel 2+, 2-: No connect
     - Module B, Channel 1+, 1-: connect to TMDS_DATA0+,–
     - Module B, Channel 2+, 2-: connect to TMDS_DATA1+,–
     - Module C, Channel 1+, 1-: connect to TMDS_DATA2+,–
     - Module C, Channel 2+, 2-: connect to TMDS_CLOCK+,–
2) Connect TPA-P to HDMI input connector of Sink DUT.
3) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) on TPA-P.

4) Configure the TMDS Signal Generator to output any Sink-supported video format and pixel size that uses the maximum Sink-supported TMDS clock frequency. If multiple formats are available, a native format is preferred. Note the tested format on the results form.

- Repeating RGB gray ramp (Ex. 0, 1, 2…254, 255, 0, 1, 2…) during each active video period.

5) For each of the TMDS clock and data pairs acting as the tested pair

- Configure the TE to support adding skew between + and – signals of the tested pair:

    6) Set the delay for all outputs to 0nS with delay offset of 2.5nS and disable "Differential Timing Offset" if previously enabled.

    7) Move the TMDS '+' signal of the tested pair to DTG output module A, 1+

    8) Move the TMDS '–' signal of the tested pair to DTG output module A, 2+

    9) Change DTG configuration to output the pattern for the tested TMDS channel on module A, 1

    10) In the DTG "Timing" screen, select the tested channel (i.e. connected to 1A1). From the "Edit" menu, enable "Differential Timing Offset".

    11) Click on the delay value in the Differential Timing Offset column and set to approximately $0.1*T_{BIT}$. This corresponds to the initial intra-pair skew value.

12) Increase the intra-pair skew (e.g. "Differential Timing Offset") by steps of less than or equal to $0.1*T_{BIT}$, until the Sink DUT outputs errors or until reaching $0.6*T_{BIT}$ or 1nsec.

13) If errors seen on DUT:

    14) Reduce the skew one step, so that Sink DUT outputs no errors.

    15) If TMDS clock frequency <= 222.75MHz:

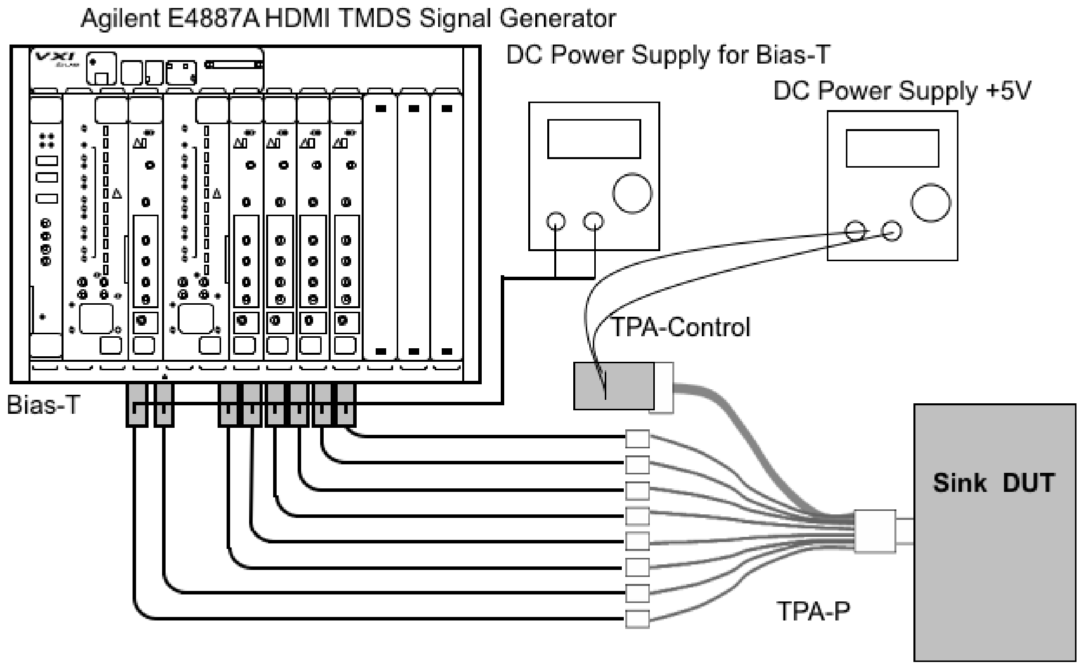
        - If intra-pair skew < $0.4*T_{BIT}$, then FAIL.

    16) Else (TMDS clock frequency > 222.75MHz):

        - If intra-pair skew < 112psecs + $0.15*T_{BIT}$, then FAIL.

17) Repeat the test for each of the remaining untested pairs.

Recommended Test Method – Agilent Test ID 8-6: TMDS – Intra-Pair Skew



Setup 41. Test ID 8-6: TMDS – Intra-Pair Skew - Agilent

No.	Description	Recommended TE	Reference	Qty.
1	TMDS Signal Generator	Agilent E4887A	4.2.1.9	1
2	Bias-T	<See reference>	4.2.1.9	8
3	DC Power Supply	<See reference>	4.2.1.15	2
4	SMA Cables	Agilent N4871A	4.2.1.7	8
5	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
6	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1

1) Setup and configure the TMDS Signal Generator and DUT:
   - Using Bias-Tees on each Agilent E4887A output, connect Agilent E4887A as follows:
     - Clockgroup A, Channel 1+, 1–: connect to TMDS_CLOCK+, –
     - Clockgroup B Channel 1+, 1–: connect to TMDS_DATA0+, – (“DATA0_P”, “DATA0_N”)
     - Clockgroup B, Channel 2+, 2–: connect to TMDS_DATA1+, –
     - Clockgroup B, Channel 3+, 3–: connect to TMDS_DATA2+, –
     - Clockgroup B Channel 4+, 4–: No connect
   - Add “60psec” TTC to each output.
2) Connect TPA-P to HDMI input connector of Sink DUT.
3) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) through TPA-Control (N1080A-H03).

4) Configure the Agilent E4887A to output any Sink-supported video format and pixel size that uses the maximum Sink-supported TMDS clock frequency. If multiple formats are available, a native format is preferred. Note the tested format on the results form.

- Repeating RGB gray ramp 0, 1, 2…254, 255, 0, 1, 2…during each active video period.

5) For each of the TMDS clock and data pairs acting as the tested pair, configure the TE to support adding skew between + and – signals of the tested pair.

   6) Set the delay for all outputs to 2.5nS in the “Timing Tab” of all outputs “Parameter Editor” of the Agilent ParBERT user software.

   7) Move the TMDS ‘-’ signal of the tested pair to Agilent E4887A Clockgroup B Channel 4-. (Leave the TMDS ‘+ signal in the original position described in step 1 above)

   8) Change Agilent E4887A configuration to output the pattern for the intra-pair skew test of TMDS channel under test.

9) Increase the intra-pair skew (e.g. “Delay” in the “Timing Tab” of the Clockgroup B Channel 4’s “Parameter editor”) by steps of less than or equal to $0.1*T_{BIT}$, until the Sink DUT outputs errors or until reaching $0.6*T_{BIT}$ or 1nsec.

10) If errors seen on DUT:

   11) Reduce the skew one step, so that Sink DUT outputs no errors.

   12) If TMDS clock frequency <= 222.75MHz:

      - If intra-pair skew < $0.4*T_{BIT}$, then FAIL.

   13) Else (TMDS clock frequency > 222.75MHz):

      - If intra-pair skew < 112psecs + $0.15*T_{BIT}$, then FAIL.

14) Repeat the test for each of the remaining untested pairs.

Test ID 8-7: TMDS – Jitter Tolerance

Reference	Requirement
[HDMI: Table 4-19] Sink AC Characteristics at TP2	TMDS Clock jitter : 0.30 T_{BIT} (relative to Ideal Recovery Clock)
[HDMI: Figure 4-14] Absolute Eye Diagram Mask at TP2 for Sink Requirements	<See reference for details.>

Test Objective

Confirm that the maximum allowed TMDS clock jitter is supported by the Sink DUT.

Required Test Method

Note that all jitter amounts described below (e.g. $0.3*T_{BIT}$) are relative to a recovered clock as measured with a Clock Recovery Unit (see Section 4.2.1.2).

Note: This test method injects two jitter components (C_JITTER, D_JITTER) simultaneously into the TMDS signals. The test uses two different jitter injection techniques and in both cases, the C_JITTER component is added to the TMDS_CLOCK signal. The D_JITTER component however, is either added to the TMDS_DATA signals or to the TMDS_CLOCK signal. For each of these cases, there are two combinations of jitter frequency.

It is required that the test be performed with D_JITTER added to the TMDS_CLOCK signal. In addition, it is optional to additionally test with the D_JITTER component instead added to the TMDS_DATA lines. This optional sequence will result in better test coverage.

The following is performed for each of the following pixel clock rates supported by the Sink: 27MHz, 74.25MHz, 148.5MHz, 222.75MHz, 297MHz. Optionally, if not already tested and if supported by the test equipment, the highest-supported rate may be tested (CDF field Sink_Max_TMDS_Clock).

For each tested TMDS clock rate:

- ❑ Operate the Sink DUT to support the HDMI input signal.
- ❑ Configure the TMDS Signal Generator as follows:
  - Output any Sink-supported video format that uses the TMDS clock rate being tested.
    - Set the common mode (average) output voltage of each TMDS signal to 3.1V
    - Set the single-ended swing of each TMDS signal to 0.4Vp-p
  - For each of the following test cases…
    - Required: D_JITTER = 500kHz (on TMDS_CLOCK), C_JITTER = 10MHz
    - Required: D_JITTER = 1MHz (on TMDS_CLOCK), C_JITTER = 7MHz
    - Optional: D_JITTER = 500kHz (on TMDS_DATA), C_JITTER = 10MHz
    - Optional: D_JITTER = 1MHz (on TMDS_DATA), C_JITTER = 7MHz
  - …do the following:

[Make TP1 worst condition]

- Set slew rate of the six + and – TMDS_DATA signals to TP1 mask using six TTCs as specified in table below.
- Set C_JITTER component to $0.25*T_{BIT}$ at TP1
- Set D_JITTER component $0.3*T_{BIT}$ at TP1

- ❑ Connect TMDS Signal Generator to Sink DUT using the 1st Cable Emulator specified for the tested TMDS clock rate, according to the following table.
  - Set C_JITTER component such that there is $0.3*T_{BIT}$ of jitter at TP2.

Typical (MHz)	Low (MHz)	High (MHz)	TTC (MHz) [1]	1st Cable Emulator	2nd Cable Emulator
27	>= 25	<=27.1	74.25	Type 1 Cat1+Cat2 (Agilent) [2]	Type 2 27MHz (JAE)
74.25	>= 27.1	<=74.25	74.25	Type 1 Cat1 (Agilent)	Type 2 75MHz (JAE)
148.5	>74.25	<=165	148.5	Type 1 Cat2 (Agilent)	Type 3 (Agilent)
222.75	>165	<=222.75	222.75	Type 1 Cat2 (Agilent)	Type 3 (Agilent)
340	>222.75	<=340	340	Type 1 Cat2 (Agilent)	Type 3 (Agilent)

Note 1: TTC values correspond to the slew rate of the leading edges of the TP1 eye diagram (shown in the HDMI specification) for the indicated TMDS_CLOCK frequency.

Note 2: The two Type 1 cable emulators are combined for a single test, resulting in higher ISI than provided by the Cat1 ISI emulator alone.

[Verify that DUT supports the signal]

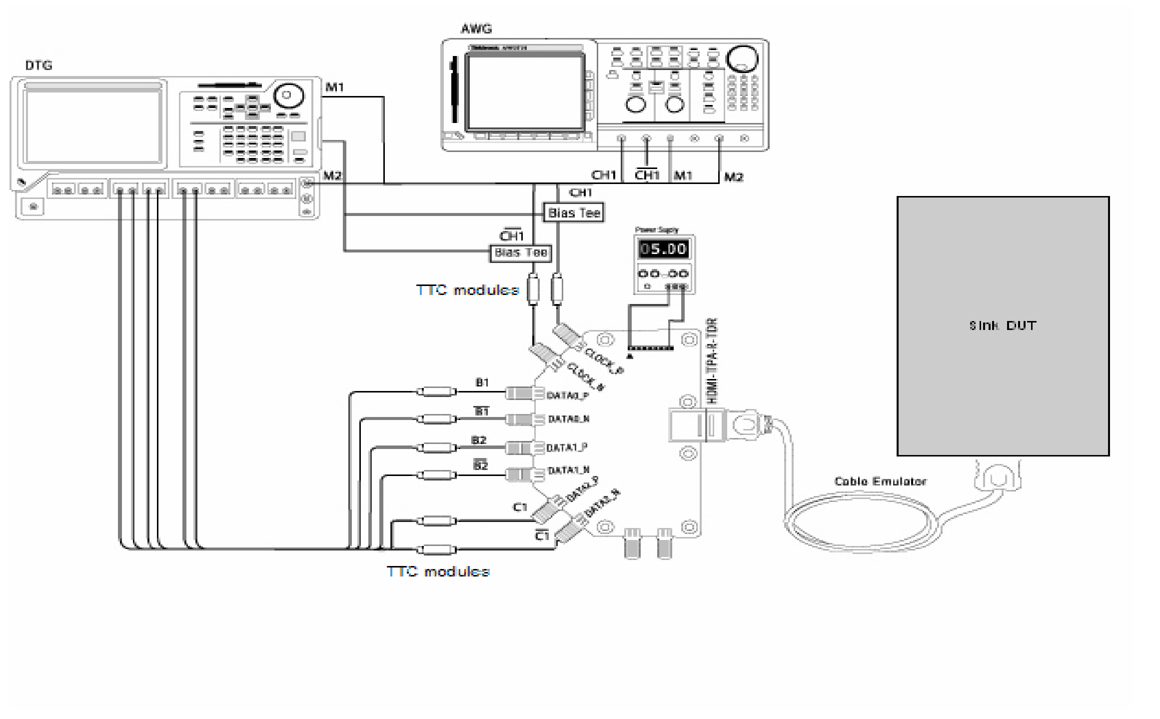
- Scan through a range of TMDS_CLOCK to TMDS_DATA skew conditions: Test skew points at least every 0.1TBIT: e.g. 0.0TBIT, 0.1TBIT…1.0TBIT. If Sink fails to adequately support signal at any point, then FAIL

- ❑ Repeat for next test case (D_JITTER/C_JITTER frequencies and location of D_JITTER)
- ❑ Remove the 1st cable emulator(s) and replace with the 2nd cable emulator (according to the entry in table above) and repeat test cases at the same test frequency.

Repeat for next test frequency, using each of the cable emulators specified for the test frequency in the table above.

Recommended Test Setup - Tektronix Up to 75MHz only

This setup cannot be used for the optional case of injecting D_JITTER on the TMDS_DATA lines.



Setup 42. Test ID 8-7: TMDS – Jitter Tolerance: Tektronix 75MHz

No.	Description	Recommended TE	Reference	Qty.
1	TMDS Signal Generator	Tektronix DTG5274 or Tektronix DTG5334	4.2.1.9	1
2	Arbitrary Waveform Generator	Tektronix AWG710	4.2.1.9	1
3	DC Power Supply	<See reference>	4.2.1.15	1
4	SMA Cables and adapters	<See reference>	4.2.1.7	as needed
5	Bias-Tees	Mini-Circuits ZFBT-4R2GW	4.2.1.9	2
6	Cable Emulator	<See reference>	4.2.1.17	1
7	TPA-R-SMA	Tektronix TPA-R-TDR or EFF-HDMI-TPA-R with EFF-E-EDID-TPA	4.2.1.1.7	1
8	Transition Time Converter (TTC)	<see reference>	4.2.1.18	<see reference>

The following must be performed for each TMDS clock rate supported by the Sink. A particular rate does not need to be tested if another rate within +/-10% of that rate has already been tested.

1) Operate the Sink DUT to support the HDMI input signal.
2) Connect the test equipment and DUT:
   - Connect the DTG, AWG, Bias-Tees, TTC and TPA-R- as follows and as shown in Setup 42 above:
     - AWG Marker 1+ output to DTG Ext.Clock input
     - AWG Marker 2+ output to DTG Trigger In
     - AWG Ch. 1+ output to Bias-Tee #1 signal input (RF)
       - Bias-Tee #1 signal output to TMDS_CLOCK+ (RF & DC)
       - DTG DC_OUT (1) to Bias-Tee #1 DC-level input (DC)
     - AWG Ch. 1– output to Bias-Tee #2 signal input (RF)
       - Bias-Tee #2 signal output to TMDS_CLOCK- (RF & DC)
       - DTG DC_OUT (2) to Bias-Tee #2 DC-level input (DC)
     - DTG Module A, Channel 1+, 1–: No connect
     - DTG Module A, Channel 2+, 2–: No connect
     - DTG Module B, Channel 1+, 1–: connect to TMDS_DATA0+,–
     - DTG Module B, Channel 2+, 2–: connect to TMDS_DATA1+,–
     - DTG Module C, Channel 1+, 1–: connect to TMDS_DATA2+,–
     - DTG Module C, Channel 2+, 2–: No connect
   - Configure AWG as follows: Under “Vertical” menu, set the following:
     - Filter-through
     - Amplitude = 0.4Vp-p
     - Offset = 0V
     - Marker 1 = 0.00V to 1.00V

- Marker 2 = 0.00V to 2.00V

3) Set the voltage of the DTG's DC_OUT (connected to the "DC" input of all Bias-Tees) to 3.1V.

4) Connect TPA-R to Sink DUT using a Cable Emulator and TTC module specified for tested TMDS clock rate.

5) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) on TPA-P.

6) Configure the DTG as follows:

   6.1) Output any Sink-supported video format that uses the TMDS clock rate being tested.

   6.2) Video data pattern: repeating RGB gray ramp (Ex. 0, 1, 2…254, 255, 0, 1, 2…) during each active video period.

   6.3) Set the voltage of the DTG's DC_OUT to 3.1V

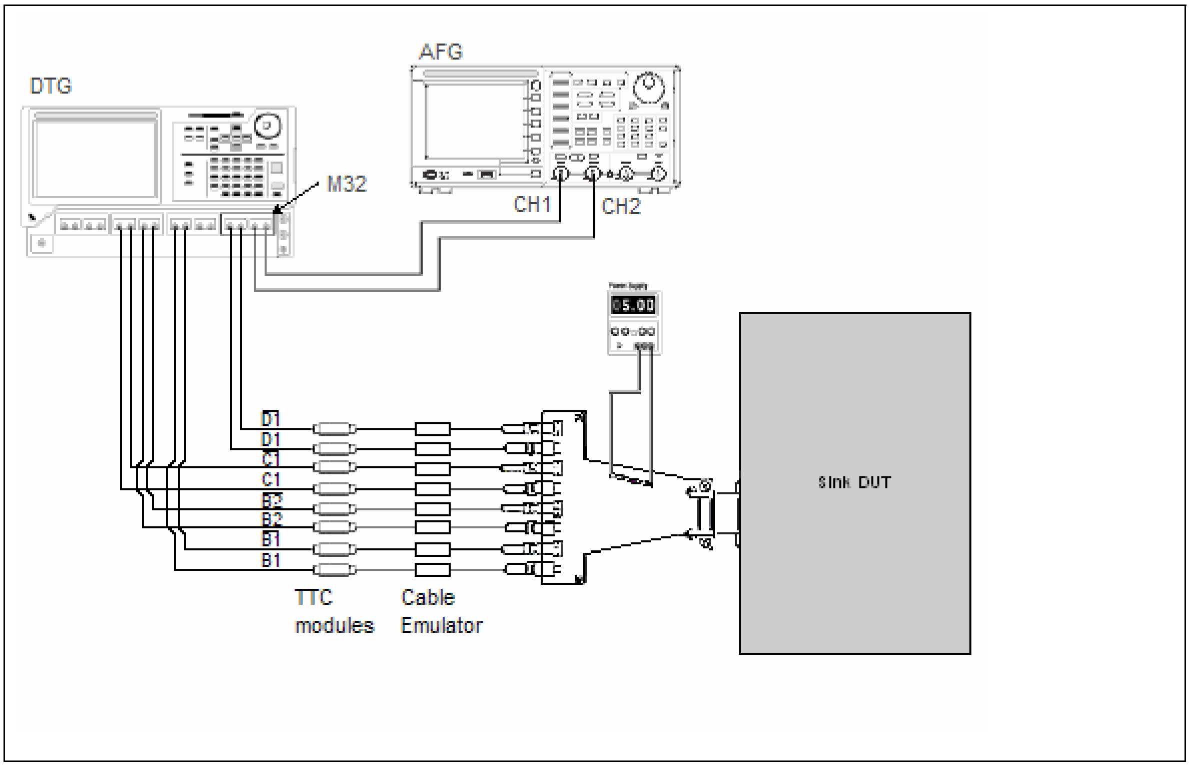
   6.4) Make the TTC output signal (without the Cable Emulator) matches to the TP1 worst signal including the jitter value (0.3*TBIT) and the slew rate.

   6.5) Connect the adequate cable emulator after the TTC.

Perform the Required Test Method with this setup.

Recommended Test Setup – Tektronix All Frequencies

This setup cannot be used for the optional case of injecting D_JITTER on the TMDS_DATA lines.



Setup 43. Test ID 8-7: TMDS – Jitter Tolerance: Tektronix All Frequencies

No.	Description	Recommended TE	Reference	Qty.
1	TMDS Signal Generator	Tektronix DTG5274 or Tektronix DTG5334 including DTGM32	4.2.1.9	1
2	Jitter Source	Tektronix AWG7102 or Tektronix AFG3102 or Tektronix AWG710/B	4.2.1.9	1
3	DC Power Supply	<See reference>	4.2.1.15	1
4	SMA Cables and adapters, as needed	<See reference>	4.2.1.7	--
5	Cable Emulator	<See reference>	4.2.1.17	1
6	TPA-P-SMA	EFF-HDMI-TPA-P with EFF-E-EDID-TPA	4.2.1.1.7	1
7	Transition Time Converter (TTC)	<see reference>	4.2.1.18	<see reference>

Note that all jitter amounts described below (e.g. $0.3*T_{BIT}$) are relative to a recovered clock as measured with a Clock Recovery Unit (see Section 4.2.1.2).

1) Connect the test equipment and DUT:
2) Connect and configure the DTG, AFG (or AWG), TTCs, and EFF-HDMI-TPA-R as follows and as shown above in setup 43

- Place M32 module in D slot of DTG.
- For AWG based setup
  - AWG Ch. 1+ output to 50ohm 20dB Attenuator input
  - DTG Module D, Jitter Control In A: 50ohm 20dB Attenuator output
  - DTG Module D, Jitter Control In B: No connect
  - AWG Ch. 1– output : No connect
  - Configure AWG as follows: Under “Vertical” menu, set the following
    - Filter-through
    - Amplitude = 1.0Vp-p
    - Offset = 0V
    - Marker 1 = 0.00V to 1.00V
    - Marker 2 = 0.00V to 2.00V
- For AFG based setup
  - AFG Ch.1 output to 50ohm 20dB Attenuator #1 input
  - DTG Module D, Jitter Control In A: 50ohm 20dB Attenuator #1 output
  - AFG Ch.2 output to 50ohm 20dB Attenuator #2 input
  - DTG Module D, Jitter Control In B: 50ohm 20dB Attenuator #2 output
  - Configure AFG as follows
    - DTG Module A, Channel 1+, 1–: No connect
    - DTG Module A, Channel 2+, 2–: No connect

- DTG Module B, Channel 1+, 1–: connect to TMDS_DATA0+,–
- DTG Module B, Channel 2+, 2–: connect to TMDS_DATA1+,–
- DTG Module C, Channel 1+, 1–: connect to TMDS_DATA2+,–
- DTG Module C, Channel 2+, 2–: No connect
- DTG Module D, Channel 1+, 1–: connect to TMDS_CLOCK+,–

3) Connect TPA-R to Sink DUT using a Cable Emulator and TTC specified for tested TMDS clock rate.

4) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) on TPA-P.

5) Configure the DTG as follows:

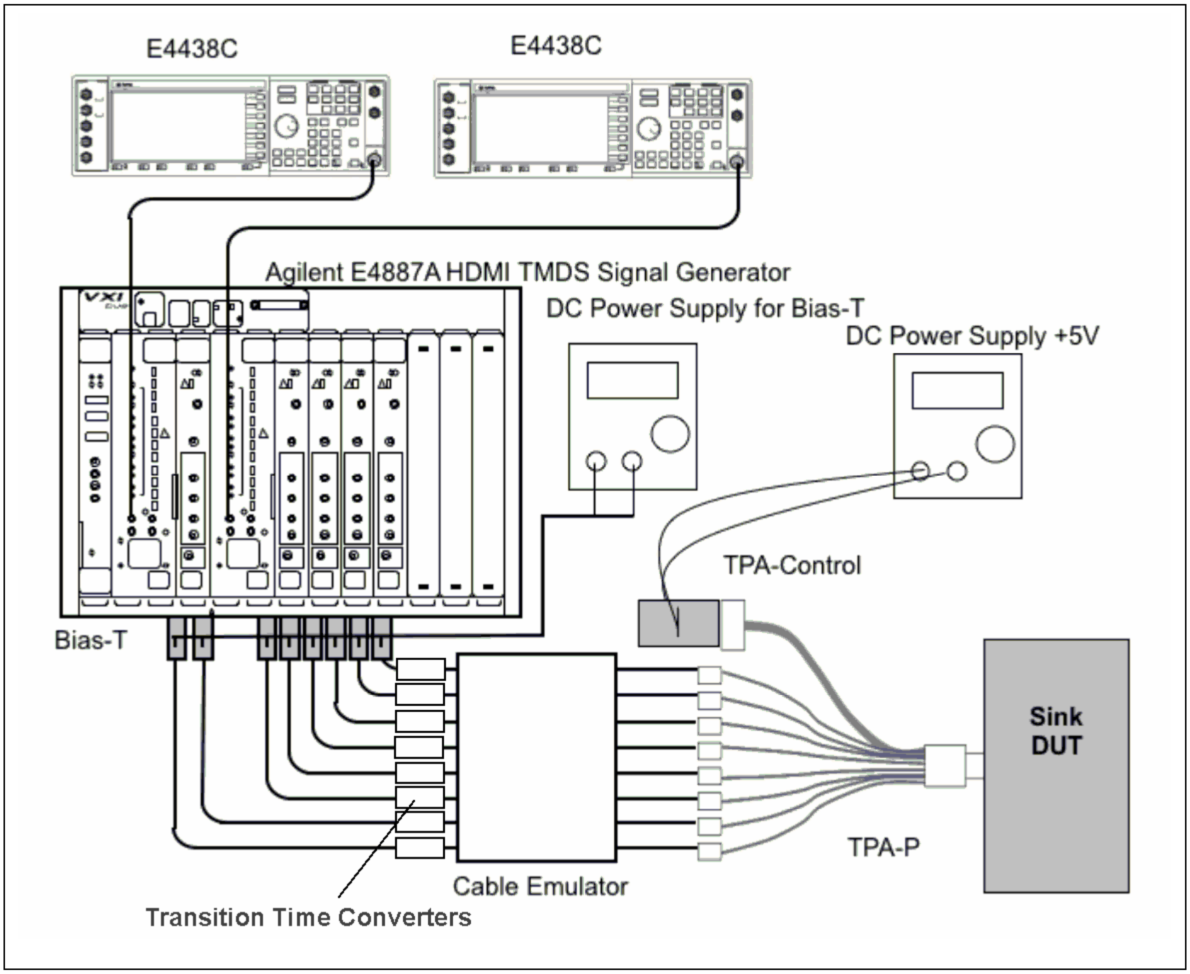
   5.1) Output any Sink-supported video format that uses the TMDS clock rate being tested.

   5.2) Video data pattern: repeating RGB gray ramp (Ex. 0, 1, 2…254, 255, 0, 1, 2…) during each active video period.

   5.3) Set the signal outputs to 3.1V average, 0.4Vp-p.

Perform the Required Test Method with this setup.

Recommended Test Setup - Agilent All Frequencies



Setup 44. Test ID 8-7: TMDS – Jitter Tolerance - Agilent

No.	Description	Recommended TE	Reference	Qty.
1	TMDS Signal Generator	Agilent E4887A	4.2.1.9	1
2	Jitter Clock Source	Agilent E4438C Signal Generators	4.2.1.9	2
3	DC Power Supply	<See reference>	4.2.1.15	2
4	SMA Cable	Agilent N4871A	4.2.1.7	8
5	Bias-Tees	<See reference>	4.2.1.9	8
6	Cable Emulator	Agilent E4887A-10x	4.2.1.17	1
7	TPA-P Test Assembly	Agilent N1080A H01	4.2.1.1.2	1
8	TPA-R Test Assembly	Agilent N1080A H02	4.2.1.1.3	1
9	TPA-Control	Agilent N1080A H03	4.2.1.1.4	1
10	Transition Time Converters	<See reference>	4.2.1.18	8

1) Operate the Sink DUT to support the HDMI input signal.

2) Connect the test equipment and DUT:

- For the Agilent E4887A, use Bias-Tees on each ParBERT output and connect E4887A as follows:
  - Clockgroup A, Channel 1+, 1–: connect to TMDS_CLOCK+, –
  - Clockgroup B Channel 1+, 1–: connect to TMDS_DATA0+, – (“DATA0_P”, “DATA0_N”)
  - Clockgroup B, Channel 2+, 2–: connect to TMDS_DATA1+, –
  - Clockgroup B, Channel 3+, 3–: connect to TMDS_DATA2+, –
  - Clockgroup B Channel 4+, 4–: No connect
  - Connect the RF output of the two Jitter Clock Sources (E4438Cs) to the two clock modules of the E4887A ParBERT
  - Connect Bias-Tees to each E4887A output for each of the TMDS_DATA and TMDS_CLOCK signals (total of 8).
  - Connect appropriate Transition Time Converters to each signal (see reference). As far the TMDS_CLOCK outputs, “60psec” TTC should be added.

3) Set the voltage of the power supply (connected to the “DC” input of all Bias-Tees) to 2.9V. [Vicm=3.1V]

4) Connect TPA-R to Sink DUT using a Cable Emulator specified for tested TMDS clock rate

5) Connect and configure DC Power Supply to drive +5V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) through TPA-Control.

Perform the Required Test Method with this setup.

Test ID 8-8: TMDS – Differential Impedance

Reference	Requirement
[HDMI: Table 4-20] HDMI Sink Impedance at TP2	Through-connection impedance : 100Ω ± 15%* ** A single excursion is permitted out to a max/min of 100 ohms ±25% and of a duration less than 250psecs.* At Termination impedance (when Vicm is within Vicm1 range) 100 ohms ±10%

Test Objective

Confirm that the TMDS input impedance of the Sink DUT is within the specified limits.

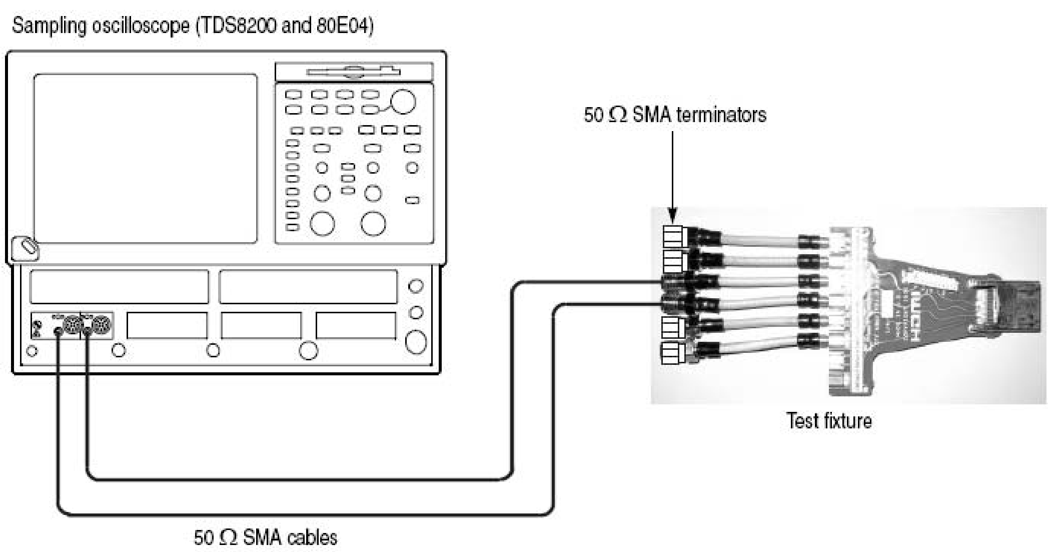
Required Test Method

- Turn off the power to the Sink DUT.
- Connect the TDR oscilloscope to cables and TPA board but do not connect TPA to the Sink DUT.
- Setup the TDR oscilloscope
  - Normalize each scope channel at the open end of the Test Line, and set an effective rise time of as close to 200ps as possible without exceeding 200ps.
- [Determine the measurement distance to DUT input connector]
  - Measure the impedance value along the tested signal path. Note point where impedance hits sharp rise toward high impedance (>200Ω). This is the distance to the Sink DUT connector.
- Connect the TPA-P fixture to the Sink DUT HDMI input connector.
- For each of the TMDS clock and data differential pairs:
  - If CDF field Sink_Diff_PowerOn is Y:
    - Measure the impedance value along the tested signal path, from the Sink DUT HDMI input connector to the input pins of the HDMI receiver, $Z_{DIFF\_THROUGH}$. This is indicated in CDF field Sink_Term_Distance.
    - If (Z_{DIFF_LOW} < 75Ω) OR (Z_{DIFF_HI} > 125Ω) then FAIL.
    - If (Z_{DIFF_LOW} < 85Ω) OR (Z_{DIFF_HI} > 115Ω) then
      - If the duration of violation is 250psec or longer or there is more than one excursion then FAIL
  - Else, if CDF field Sink_Diff_PowerOn is N, perform the following:
    - Measure the impedance value ($Z_{DIFF\_THROUGH}$) along the signal path, from the HDMI input connector until just before the termination impedance (where the impedance stabilizes).
    - If (Z_{DIFF_LOW} < 75Ω) OR (Z_{DIFF_HI} > 125Ω) then FAIL.
    - If (Z_{DIFF_LOW} < 85Ω) OR (Z_{DIFF_HI} > 115Ω) then
      - If the duration of violation is 250psec or longer or there is more than one excursion then FAIL

- Measure the impedance value (Z_{DIFF_TERM}) of the termination impedance (where the impedance stabilizes).
- If (Z_{DIFF_LO} < 85Ω) OR (Z_{DIFF_HI} > 115Ω) then FAIL.

- Repeat this measurement for each of the TMDS differential pairs.
- If CDF field Sink_Diff_PowerOn is Y, note that TDR usage under power-on conditions can lead to damage to the TDR oscilloscope. Consequently, the ATC may skip power on testing.

Recommended Test Method Test ID 8-8: TMDS – Differential Impedance



Setup 45. Test ID 8-8: TMDS – Differential Impedance

No.	Description	Recommended TE	Reference	Qty.
1	TDR/TDT Oscilloscope	Tektronix TDS8200B	4.2.1.11	1
2	DC Power Supply	<See reference>	4.2.1.15	1
3	50Ω SMA Terminators	<See reference>	4.2.1.8	6
4	SMA cables	<See reference>	4.2.1.7	2
5	TPA-P-TDR Fixture	EFF-HDMI-TPA-P	4.2.1.1.6	1

Note that the following should be performed in accordance with the instructions found in "*Tektronix HDMI Sink Instruments Differential Measurement Procedures Guide"*, available from Tektronix.

1) Turn off the power to the Sink DUT.
2) Connect the TPA-P-TDR fixture to the Sink DUT HDMI input connector. Note that SMA cables which can support a very fast rise time should be used.
3) Terminate all non-tested TMDS differential pairs with 50Ω terminators.
   3) Adjust the skew between the two measurement channels to less than 5ps, following the manufacturer's instruction (Refer to the section labeled "*Calibration"* in the *Procedures Guide*).

4) Set an effective rise time of as close to 200ps as possible without exceeding 200ps by using the digital filter of the TDR (Refer to the section labeled "*Setting the Rise Time*" in the *Procedures Guide*).

5) Set vertical scale to 5Ω/division, and horizontal scale to 100ps/division.

Perform the steps in the Required Test Method. (Refer to the section labeled "*Measuring the Impedance*" in the *Procedures Guide*).

Test ID 8-9: DDC/CEC Line Capacitance and Voltage

Reference	Requirement
[HDMI: 4.2.8] DDC	"The Display Data Channel (DDC) I/Os and wires … shall meet the requirements specified in the I^2C Specification, version 2.1, Section 15 for 'Standard Mode' devices."
[HDMI: Table 4-20] Maximum Capacitance of DDC Line	SDA capacitance must be ≤ 50pF. SCL capacitance must be ≤ 50pF.
[HDMI: Table 4-24] CEC line Electrical Specifications for all Configurations	Maximum (CEC line) capacitance load of a Sink or of a CEC root device: 200pF.

Test Objective

Confirm that the capacitance load on the DDC and CEC lines does not exceed the limit in the specification.

Required Test Method

NOTE for Repeater DUTs: This test only needs to be performed once per connector. If test has already been performed on this port, then SKIP.

1) Turn on power to the DUT.
2) Set the LCR meter test signal:
   - DC Bias voltage = 2.5V
   - AC voltage = 3.5V peak-to-peak
   - Frequency = 100kHz
3) Verify that the test equipment, including fixtures, is disconnected from the DUT.
4) Drive +5.0V between +5V Power signal and DDC/CEC Ground signal on the TPA.
5) Connect the DDC/CEC Ground signal to the frame ground of the TPA.
6) Measure the capacitance of the SDA line. This is the inherent test equipment capacitance, C1.
7) Attach the test equipment to the DUT and measure the capacitance of the SDA line. This is the total capacitance, C2.

8) DUT capacitance, $C_{DUT} = C2 – C1$.

9) If C_{DUT} > 50pF, then FAIL.

10) Repeat the C1 and C2 measurements and the C_{DUT} calculation for the SCL pin.

11) If C_{DUT} > 50pF, then FAIL.

12) Set the LCR meter test signal:
- DC Bias voltage = 1.65V
- AC voltage = 2.5V peak-to-peak
- Frequency = 100kHz

13) Disconnect the TPA from the DUT.

14) Perform the C1 measurement for the CEC pin on the TPA.

15) Turn off power to the DUT.

16) If DUT is being tested as a Repeater under Test ID 9-3, disconnect all test Sink(s) (HDMI Monitor and Speaker).

17) Repeat the C2 measurement and the C_{DUT} calculation for the CEC pin (C_{DUT_ON}).

18) Turn on power to the DUT.

19) Repeat the C2 measurement and the C_{DUT} calculation for the CEC pin (C_{DUT_OFF}).

20) If DUT has no output ports (CDF field HDMI_output_count == 0) or if DUT is CEC root device (CDF field CEC_root_device = "Y") then:

    21) If C_{DUT_ON} > 200pF, then FAIL.

    22) If C_{DUT_OFF} > 200pF, then FAIL.

    Else (DUT is a Repeater but not a CEC root device)

    23) If C_{DUT_ON} > 150pF, then FAIL.

    24) If C_{DUT_OFF} > 150pF, then FAIL.

25) Disconnect the LCR meter from the TPA.

26) Drive +5.0V between +5V Power signal and DDC/CEC Ground signal on the TPA.

27) Turn on power to the DUT.

28) Attach the oscilloscope to the DUT and measure the voltage (V_{SCL}) of the SCL line when not being driven low.

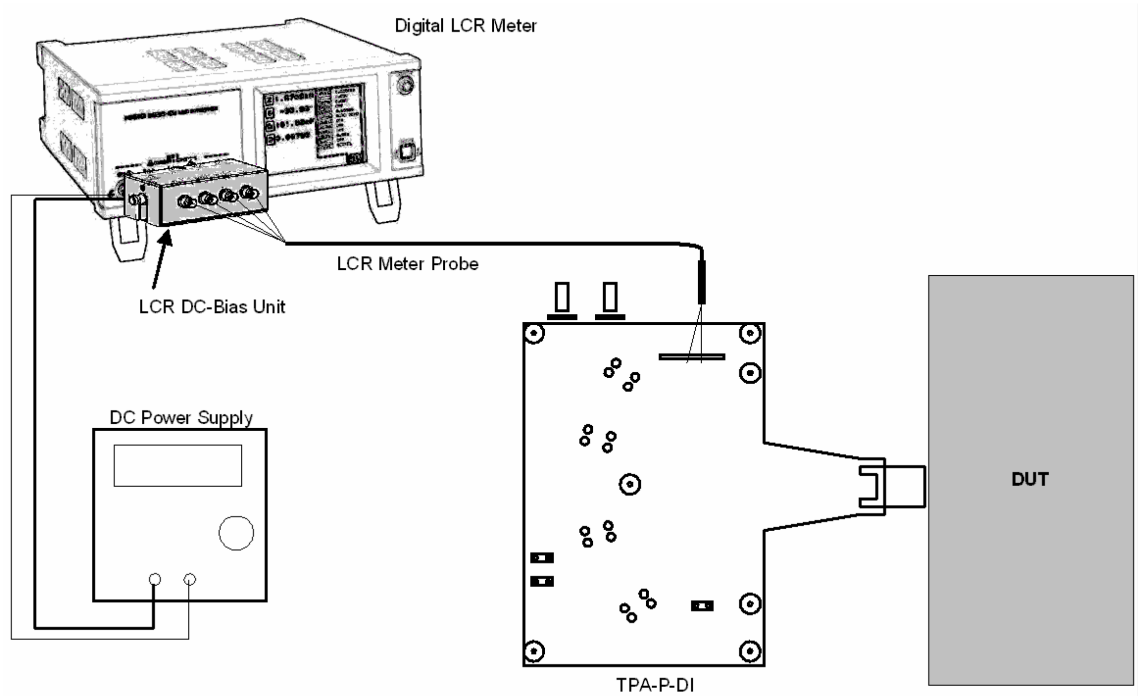
29) If V_{SCL} < 4.5V or V_{SCL} > 5.5V then FAIL

30) Measure the voltage (V_{CEC}) of the CEC line when not being driven low.

31) If V_{CEC} > 0.6V and (V_{CEC} < 2.5V or V_{CEC} > 3.6V) then FAIL

32) If DUT is being tested as a Repeater, reconnect test Sink(s) before proceeding.

Recommended Test Method



Setup 46. Test ID 8-9: DDC/CEC Line Capacitance and Voltage

No.	Description	Recommended TE	Reference	Qty.
1	Digital LCR Meter	HIOKI 3522-50	4.2.1.16	1
2	LCR Meter Probe	HIOKI 9143	4.2.1.16	1
3	LCR DC-Bias Unit	HIOKI 9268-01	4.2.1.16	1
4	Digital Multi-Meter	<See reference>	4.2.1.13	1
5	DC Power Supply 3.3V	<See reference>	4.2.1.15	1
6	TPA-P	Any unterminated TPA giving access to DDC & CEC signals	4.2.1.1	TPA-P
7	General Oscilloscope	<Any>	4.2.3.4	1

- Perform the steps in the Required Test Method using the Test Equipment listed above. In all capacitance measurements, connect the Hioki DC-Bias Unit in an inverted configuration:
  - Supply the DC bias voltage in the direction opposite from a typical configuration.
  - As shown in setup above, probe polarity should also be connected in an inverted direction.(i.e. GND line is connected to H port of the probe, and Signal line to L port.) Note that, for accurate measurement, the earth line (3rd pin) of the AC plug should be disconnected for both the HIOKI-3522-50 and DC-power supply.

Test ID 8-10: HPD Output Voltage

Reference	Requirement
[HDMI: Table 4-22] Required Output Characteristics of Hot Plug Detect Signal	The high voltage level must be within 2.4V to 5.3V. The low voltage level must be within 0.0V to 0.4V.

Test Objective

Confirm that the Hot Plug Detect signal returned from the Sink conforms to the specified voltage levels, and that it is not asserted when the +5V Power signal is not asserted.

Required Test Method

Note: Use 0.1 Volt resolution for the comparison (i.e. 0.0 means 2 significant digits).

1) Connect TPA to HDMI input connector of Sink DUT.
2) Connect DC power supply to +5V pin on TPA.

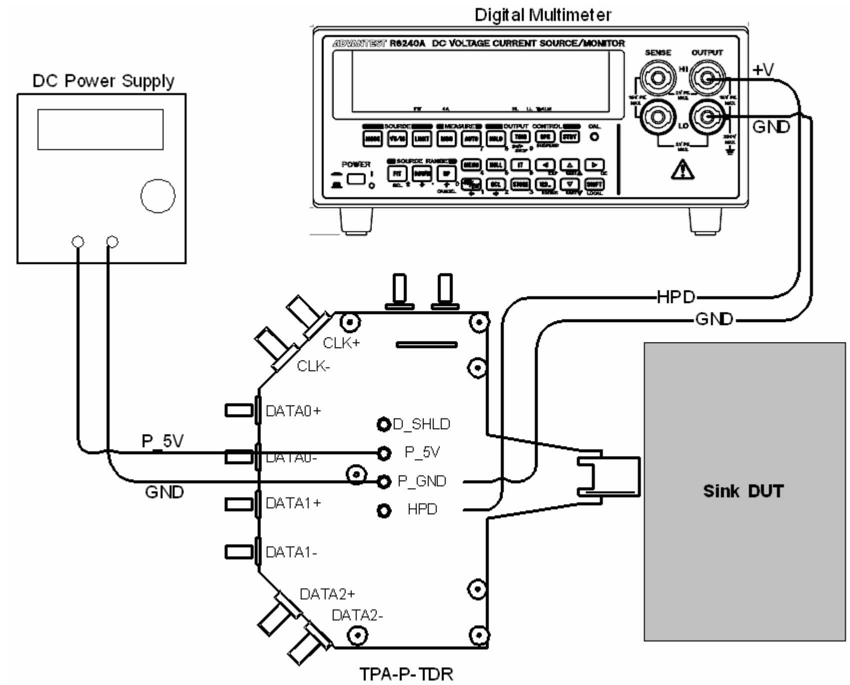
[Verify that HPD is FALSE when +5V Power Signal is 0V]

3) Set the +5V Power pin to 0.0V
    4) Put the Sink DUT in a power-on and active condition
    5) Measure voltage on the HPD pin of TPA (V_{HPD_L1}),
    6) If (V_{HPD_L1} < 0.0V OR V_{HPD_L1} > 0.4V) then FAIL.
    7) If a standby mode is available on the DUT, then:
        8) Put the Sink DUT in standby
        9) Measure voltage on the HPD pin of TPA-P-TDR (V_{HPD_L2}),
        10) If (V_{HPD_L2} < 0.0V OR V_{HPD_L2} > 0.4V) then FAIL.
    11) Put the Sink DUT in power OFF condition
    12) Measure voltage on the HPD pin of TPA-P-TDR (V_{HPD_L2}),
    13) If (V_{HPD_L2} < 0.0V OR V_{HPD_L2} > 0.4V) then FAIL.

[Verify that HPD TRUE is in proper voltage range]

14) If CDF field Sink_HPD_True does not equal “None”, perform any actions specified in CDF field Sink_HPD_True.
    15) For +5V Power voltages of 4.8V and 5.3V, perform the following:
        16) Measure voltage on the HPD pin of TPA (V_{HPD_H})
        17) If (V_{HPD_H} < 2.4V OR V_{HPD_H} > 5.3V) then FAIL

Recommended Test Method — Test ID 8-10: HPD Output Voltage



Setup 47. Test ID 8-10: HPD Output Voltage

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	DC Power Supply	<See reference>	4.2.1.15	1
3	TPA-P	Any unterminated TPA giving access to DDC & CEC signals	4.2.1.1	1

Perform the steps in the Required Test Method using the Test Equipment shown above.

Note: Use 0.1 Volt resolution for all voltage comparisons. (i.e. 0.0 means 2 significant digits)

Test ID 8-11: HPD Output Resistance

Reference	Requirement
[HDMI: Table 4-22] Required Output Characteristics of Hot Plug Detect Signal	The output resistance of the HPD pin must be 1000Ω ±20%.

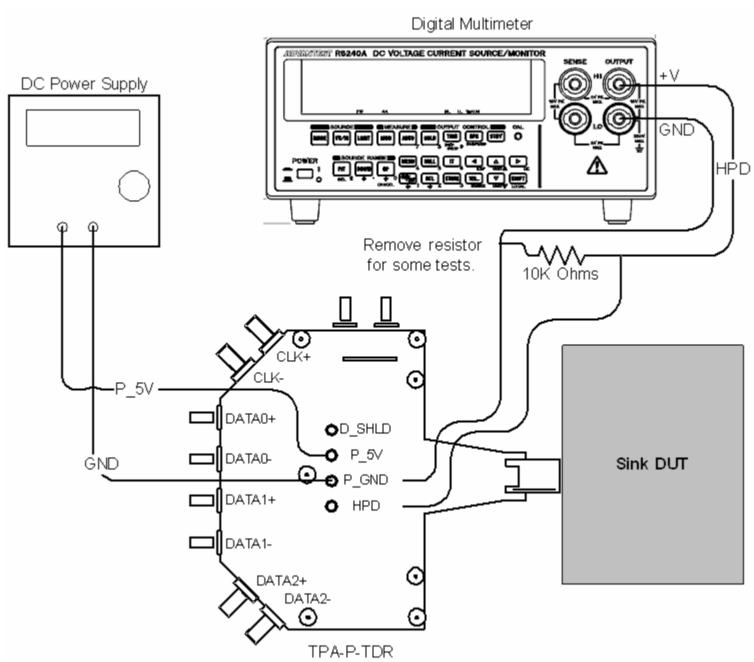
Test Objective

Confirm that the HPD pin on the Sink DUT presents the proper impedance to the source device.

Required Test Method

- ❑ Connect TPA-P to Sink DUT.
- ❑ Drive +5.0V between +5V Power (P_5V) and DDC/CEC Ground (P_GND) on TPA-P.
- ❑ If CDF field Sink_HPD_True does not equal “None”, perform any actions specified in CDF field Sink_HPD_True.
- ❑ Measure the voltage of the HPD pin on the TPA-P (V_A).
- ❑ Connect a 10kΩ resistor between HPD pin and DDC/CEC Ground.
- ❑ Measure the HPD pin voltage (V_B).
- ❑ Calculate output resistance on HPD pin as:
  - $Z_{HPD} = (V_A/V_B – 1) * 10,000$
- ❑ If ($Z_{HPD} < 800\Omega$) OR ($Z_{HPD} > 1200\Omega$) then FAIL

Recommended Test Method Test ID 8-11: HPD Output Resistance



Setup 48. Test ID 8-11: HPD Output Resistance

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
3	DC Power Supply	<See reference>	4.2.1.15	1
3	10kΩ resistor	<any>		
4	TPA-P	Any unterminated TPA giving access to DDC & CEC signals	4.2.1.1	1

1) Connect TPA-P to Sink DUT.

2) Connect DC Power Supply between +5V Power (P_5V) and DDC/CEC Ground (P_GND) on TPA-P.

3) Set DC Power Supply to output +5.0V.

4) If CDF field Sink_HPD_True does not equal “None”, perform any actions specified in CDF field Sink_HPD_True.

5) Measure the voltage of the HPD pin on the TPA-P (V_A).

6) Connect a 10kΩ resistor between HPD (HOT_PLUG) pin and DDC/CEC Ground (P_GND).

7) Measure the HPD pin voltage (V_B).

8) Calculate output resistance on HPD pin as:

- $Z_{HPD} = (V_A/V_B - 1) * 10{,}000$

9) If (Z_{HPD} < 800Ω) OR (Z_{HPD} > 1200Ω) then FAIL

Test ID 8-12: +5V Power Max Current

Reference	Requirement
[HDMI: 4.2.7] +5V Power Signal	“A Sink shall not draw more than 50mA of current from the +5V Power pin. When the Sink is powered on, it can draw no more than 10mA from the +5V Power signal.”

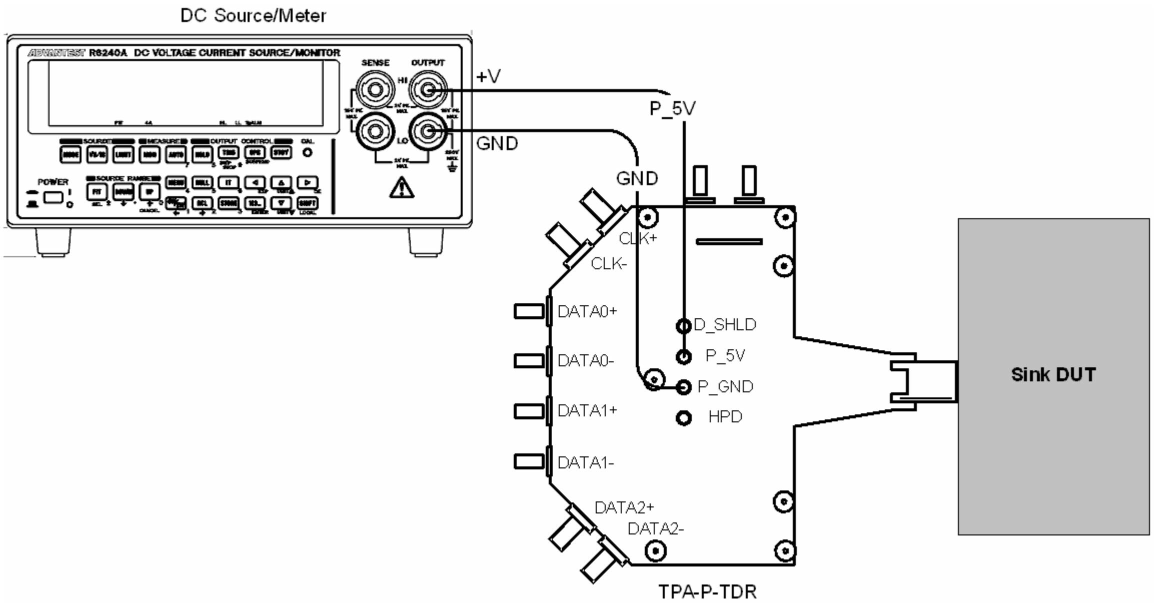
Test Objective

Confirm that the Sink DUT does not consume more power than allowed when in either the ON or OFF state, from the +5V Power pin.

Required Test Method

- ❑ Connect TPA-P to HDMI input connector of Sink DUT.
- ❑ For the three cases, Sink DUT powered ON, Sink DUT powered OFF, and Sink DUT disconnected from AC power source, do the following:
- ❑ Set current limit of power supply to 65mA
- ❑ For the two voltages at the +5V pin of 4.9V and 5.1V, do the following:
  - Measure the current drawn through the +5V Power pin by the Sink, I_{SINK}
  - If (Sink DUT power is ON) AND ($I_{SINK} \geq$ 10mA) then FAIL.
  - If (Sink DUT power is OFF or disconnected from AC) AND ($I_{SINK} \geq$ 50mA) then FAIL.

Recommended Test Method — Test ID 8-12: +5V Power Max Current



Setup 49. Test ID 8-12: +5V Power Max Current

No.	Description	Recommended TE	Reference	Qty.
1	DC Source/Meter and Probe	ADVANTEST R6240A	4.2.1.12	1
2	TPA-P	Any unterminated TPA giving access to control signals	4.2.1.1	1

1) Connect TPA-P-TDR to HDMI input connector of Sink DUT.
2) For the three cases, Sink DUT powered ON, Sink DUT powered OFF, and Sink DUT disconnected from AC power source, do the following:
3) Set current limit of power supply to 65mA
4) For the two voltages at the +5V pin of 4.9V and 5.1V, do the following:
    5) Measure the current drawn through the +5V Power pin by the Sink, I_{SINK}
    6) If (Sink DUT power is ON) AND ($I_{SINK} \geq$ 10mA) then FAIL.
    7) If (Sink DUT power is OFF or disconnected from AC) AND ($I_{SINK} \geq$ 50mA) then FAIL.

Test ID 8-13: CEC Line Connectivity

Reference	Requirement
[HDMI: Table 4-24] CEC Line Connectivity	<See reference for details>

Test Objective

Ensure that CEC lines on all inputs and outputs are connected as specified in following description:

CEC lines from all HDMI inputs (if present) and a single HDMI output (if present) shall be interconnected.

Except :

- A device which has no HDMI output is allowed to have separate CEC lines for each HDMI connector if that device takes a logical address of 0 on each CEC line.
- A device that is acting as the CEC root device shall not connect the CEC line to any HDMI output.

Required Test Method

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document. If test has already been performed on product, then SKIP.

[Verify correct CDF fields: Independent CEC may be set only if DUT has no HDMI output and only if DUT is performing CEC operations at logical address 0]

- ❑ If CDF field Independent_CEC = "Y" then:
  - If CDF field HDMI_output_count > 0 then FAIL
  - If CDF field CEC_protocol <> "Y" then FAIL

[Verify that CEC pins on all input connectors are tied together]

- ❑ Turn DUT off
- ❑ For every combination of two HDMI input connectors on the DUT:
  - Measure the resistance between the CEC pins of the two connectors.
  - If any resistance measurement > 5Ω then:
    - If CDF field Independent_CEC = "N" then FAIL
    - If resistance < 48kΩ then FAIL

[Verify that DUT has CEC connected to only 1 output]

- ❑ For every output connector;
  - Measure the resistance between the CEC pin of that output connector and the CEC pin of each input connector.
  - If resistance is between 5Ω and 1MΩ then FAIL
  - If resistance is less than 5Ω then note the output connection ID.
- ❑ If more than one output connection ID noted then FAIL
- ❑ If no output connection ID noted,
  - If CDF field CEC_root_device = "N" then FAIL

Recommended Test Method

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	TPA-P	Any unterminated TPA giving access to DDC & CEC signals	4.2.1.1	2

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document. If test has already been performed on product then SKIP.

[Verify correct CDF fields]

1) If CDF field Independent_CEC = “Y” then:
    2) If CDF field HDMI_output_count > 0 then FAIL
    3) If CDF field CEC_protocol <> “Y” then FAIL

[Verify that CEC pins on all input connectors are tied together]

4) Turn DUT off
5) Set Digital Multi-Meter to measure resistance using auto scale mode.
6) Connect one probe of the meter to the CEC pin on the first TPA-P
7) Connect the other probe of the meter to the CEC pin on the second TPA-P
8) For every combination of two HDMI input connectors on the DUT
    9) Connect first TPA-P to first selected HDMI connector
    10) Connect second TPA-P to second selected HDMI connector
    11) Read resistance value from Digital Multi-Meter
    12) If reading is greater than 5Ω then:
        13) If CDF field Independent_CEC = “N” then FAIL
        14) If resistance < $48k\Omega$ then FAIL

[Verify that DUT has CEC connected to at most 1 output]

15) For every HDMI output connector:
    16) Connect first TPA-P to selected HDMI output connector
    17) For every HDMI input connector:
        18) Connect second TPA-P to selected HDMI input connector
        19) Read resistance value from Digital Multi-Meter
        20) If resistance is between 5Ω and $1M\Omega$ then FAIL
        21) If resistance is less than 5Ω then note the output connection ID.
    22) Continue to next input connector

23) Continue to next output connector

24) If more than one output connection ID noted then FAIL, "CEC line connected to > 1 output"

25) If no output connection ID noted,

26) If CDF field CEC_root_device = "N" then FAIL, "CEC line not connected to any output"

Test ID 8-14: CEC Line Degradation

Reference	Requirement
[HDMI: Table 4-27] CEC line Electrical Specifications for all Configurations	A device with power removed (from the CEC circuitry) shall not degrade communication between other CEC devices (e.g. the line shall not be pulled down by the powered off device). Maximum CEC line leakage current must be ≤1.8μA

Test Objective

Ensure that the DUT does not degrade communication between other CEC devices when power is applied, when power is removed and, if supported, in standby mode (the line must not be pulled down by the powered off device).

Required Test Method

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document.

- ❑ If DUT is being tested as a Repeater under Test ID 9-1, disconnect all test Source(s) and Sink(s).
- ❑ If CDF field CEC_protocol is N then
  - Connect the CEC line on DUT to DDC/CEC Ground via a 1MΩ ±5% resistor
  - Power on DUT

  [Measure voltage when "disconnected"]
    - Measure CEC line voltage on DUT and record as V_{CEC1}.
    - If V_{CEC1} is in the range 0V to 0.1V [no connect] or is in the range > 2.88V to 3.63V then continue else then FAIL
  - Disconnect the CEC line from DDC/CEC Ground

  [Measure voltage when "pulled-up externally"]
  - Connect the CEC line to 3.3V via a 27kΩ ±5% resistor
    - Measure CEC line voltage.
    - If voltage not 3.3V ±10% then → FAIL

  [Measure voltage when "pulled-down externally"]
  - Connect the CEC line on the DUT to DDC/CEC Ground via 1kΩ ±5% load resistor (as well as the previously connected 3.3V via 27kΩ±5%)

- Measure CEC line voltage on the DUT output connector and record as V_{CEC2}
- If V_{CEC1} is in the range 0V to 0.1V and V_{CEC2} is not in the range 0.12V ±12% then → FAIL
- If V_{CEC1} is in the range 2.88V to 3.63V and V_{CEC2} is not in the range 0.196V to 0.274V then → FAIL

• Repeat tests with DUT in power off state

• If standby power mode exists on DUT, repeat test in that state

[Perform following for all DUTs whether or not they support CEC_protocol]

❑ Remove power (mains) from DUT

❑ Disconnect CEC line from both resistors going to DDC/CEC Ground and 3.3V

❑ Connect CEC line to 3.63V via 27kΩ ±5% resistor with ammeter in series

❑ Measure the CEC line leakage current. If current > 1.8µA then → FAIL

❑ If DUT is being tested as a Repeater, reconnect test Source(s)/Sink(s) before proceeding.

Recommended Test Method

No.	Description	Recommended TE	Reference	Qty.
1	Digital Multi-Meter	<See reference>	4.2.1.13	1
2	DC Power Supply	<See reference>	4.2.1.14	1
3	27kΩ±5% resistor	<any>		1
4	1kΩ±5% Resistor	<any>		1
5	1MΩ±5% Resistor	<any>		1
6	TPA-P	Any TPA giving access to CEC signals	4.2.1.1	1

TPA-CEC-R incorporates the resistances shown above and so may be used instead of other TPA-P and discrete resistors.

NOTE: This test only needs to be performed once per product, not once per connector as with all of the other tests in this document.

1) If DUT is being tested as a Repeater under Test ID 9-1, disconnect all test Sources and Sink(s).
2) If CDF field CEC_protocol is N then
   3) Connect TPA to DUT
   4) Set DC Power Supply to 3.3V
   5) Connect the CEC line to DDC/CEC Ground on the TPA-P via a 1MΩ ±5% resistor
   6) Set Multi-Meter to voltage measurement and connect between CEC pin and DDC/CEC Ground on TPA

7) Power on DUT
   8) Measure voltage with Multi-Meter, record as V_{CEC1}
   9) if (V_{CEC1} is in the range 0V to 0.1V) or (V_{CEC1} is in the range 2.88V to 3.63V) then continue else then FAIL
   10) Disconnect the CEC line from DDC/CEC Ground
   11) Connect the CEC line on TPA to DC Power Supply (3.3V) via the 27kΩ ±5% resistor
   12) Measure voltage; if voltage is not 3.3V ±10% then → FAIL
   13) Connect the CEC line on the TPA to DDC/CEC Ground on TPA via 1kΩ ±5% load resistor (as well as the previously connected 3.3V via 27kΩ)
   14) Measure voltage, record as V_{CEC2}
   15) If V_{CEC1} in the range 0V to 0.1V and V_{CEC2} is not in the range 0.12V ±12% then → FAIL
   16) If V_{CEC1} >= 2.88V and <= 3.63V and V_{CEC2} is not in the range 0.196V to 0.274V then → FAIL
17) Repeat tests with DUT in power off state
18) If standby power mode exists on DUT, repeat test in that state

[Perform following for all DUTs whether or not they support CEC_protocol]

19) Remove power (mains) from DUT
20) Disconnect CEC line from both resistors going to DDC/CEC Ground and 3.3V
21) Set DC Power Supply to 3.63V
22) Connect the CEC line on the TPA input connector to one end of 27kΩ resistor
23) Set Multi-Meter to current measurement and connect between free end of 27kΩ resistor and DC power supply.
24) From multi-meter, record leakage current. If measured current > 1.8µA then → FAIL
25) If DUT is being tested as a Repeater, reconnect test Source(s)/Sink(s) before proceeding.

8.4 Sink – Protocol

The Sink DUT must be turned on and configured to accept signals via the HDMI input. Some mechanism must be in place to determine if Sink DUT is adequately supporting the transmitted audio and video signals.

The conditions in the following tests will be generated by the TE to verify the Sink DUT's support. The Sink must continually support the transmitted signal during the entire sequence of test conditions.

Test ID 8-15: Character Synchronization

Reference	Requirement
[HDMI: 5.2.1.2] Character Synchronization	The Sink is required to establish synchronization with the data stream during any Control Period greater than or equal to $t_{S,min}$ (12) characters in length.

Test Objective

Verify that the Sink establishes synchronization with the data when it receives only minimum-length Control Periods.

Required Test Method

- Connect the Sink DUT to a TMDS Signal Generator
- Begin with no TMDS clock.
- TMDS Signal Generator starts transmission of valid 640x480p video frame with every horizontal and vertical blanking interval completely filled with one or more Data Islands and with all Control Periods either 12 or 13 characters in length. Note: 640x480p has 160 pixels in HBLANK low. Best arrangement is: 13+2+32+32+32+32+2+13 = 158 (plus two Video Guardband characters). There are 7200 pixels in VBLANK so multiple arrangements may be possible.
- If Sink DUT does not support the transmitted signal then FAIL

Recommended Test Method

- Connect TPA-P to HDMI input connector of Sink DUT.
- Connect TMDS Signal Generator to all TMDS differential pairs.
- Configure the TMDS Signal Generator to output above required test signal pattern but with outputs disabled.
- Enable outputs.
- If Sink adequately supports signal then PASS, else then FAIL

Test ID 8-16: Acceptance of All Valid Packet Types

Reference	Requirement
[HDMI: 5.3] Data Island Packet Definition	"Sink shall support reception of any valid packet type."

Test Objective

Verify that Sink supports reception of all valid packet types.

Required Test Method

- ❑ Configure protocol generator to transmit 720x480p (if Sink_60Hz = "Y") or 720x576p (if Sink_60Hz = "N"), 2 channel 48kHz audio HDMI signal with following characteristics:
  - During VBLANK, one or more Data Islands contain a valid
    - Null Packet (0x00)
    - General Control Packet (0x03)
      - with Set_AVMUTE and Clear_AVMUTE clear (0).
    - Vendor-specific InfoFrame Packet (0x81)
      - with a length of 3 and a 24-bit IEEE registration identifier belonging to the HDMI Licensing, LLC (0x000C03).
    - AVI InfoFrame Packet (0x82)
    - Source Product Description Packet (0x83)
    - Audio InfoFrame Packet (0x84)
    - MPEG Source InfoFrame Packet (0x85).
  - If Sink DUT does not adequately support the signal then FAIL
  - If CDF field Sink_Supports_AI is Y:
    - Configure protocol generator to also transmit, during VBLANK, one or more Data Islands containing a valid
      - ACP Packet (0x04)
      - ISRC1 Packet (0x05)
      - ISRC2 Packet (0x06)
    - If Sink DUT does not adequately support the signal then FAIL
  - If CDF field Sink_xvYCC is Y:
    - Configure protocol generator to also transmit valid xvYCC-encoded video and, during VBLANK, one or more Data Islands containing a valid
      - Gamut Metadata Packet (0x0A) with P0 transmission profile
    - If Sink DUT does not adequately support the signal then FAIL

Recommended Test Method

1) Connect TPA-P to HDMI input connector of Sink DUT.

2) Connect A/V Protocol Generator to all TMDS differential pairs.

3) Configure the A/V Protocol Generator to output above required Test signal pattern..

4) If Sink adequately supports signal then PASS, else FAIL

8.5 Sink – Video

Test ID 8-17: Basic Format Support Requirements

Reference	Requirement
[861-D: 7.2.2] Full 861-D Implementation	If a CEA-861-D video format is supported by the Sink, it shall be indicated in an SVD and optionally, by a DTD.
	All 240 and 480 line 861-D formats described in DTD shall be listed as 59.94Hz.
	All 720 and 1080 line 861-D formats described in DTD, near 59.94/60Hz shall be listed as 60Hz.

Test Objective

Verify that no CEA video format is declared only in a DTD.

Required Test Method

Note that aspect ratios (AR) for DTDs are calculated using the horizontal and vertical size parameters in bytes 12, 13 and 14, as:

ar = Horizontal_Size / Vertical_Size

if 1.2667 < ar < 1.4 then AR = 4:3 [1.33 ± 5%]

else if 1.6889 < ar < 1.8667 then AR = 16:9 [1.78 ± 5%]

else, AR = unknown.

- ❑ [If an CEA video format is supported by the Sink, it shall be indicated by an SVD and optionally, by a DTD.]
  - For each DTD in EDID:
    - Examine DTD for match with any CEA format. Such a DTD will have:
      - All fields in the DTD for horizontal and vertical active and total correspond to the values shown in CEA-861-D Table 4, for a specific format. Note that the vertical active value in the DTD will have half the value in Table 4 if the format is interlaced.
      - Pixel clock frequency in bytes 0 and 1 within ±1% of CEA-specified frequency for the format.
      - Aspect ratio (calculated as H/V) within ±5% of either 16:9 or 4:3.
    - If DTD matches any CEA format, search SVDs for that same video format at same aspect ratio.
    - If no matching SVD then FAIL

- If DTD resolution exactly matches one of the following 59.94/60Hz formats, and pixel clock is within ±1% of specified…

Format ID	Resolution	Pixel Clock
1	640x480p	25.175MHz [=0x09D6]
2 or 3	720x480p	27.00MHz [=0x0A8C]
14 or 15	1440x480p	54.00MHz [=0x1518]
6 or 7	1440x480i	27.00MHz
10 or 11	2880x480i	54.00MHz
8 or 9	1440x240p	27.00MHz
12 or 13	2880x240p	54.00MHz
4	1280x720p	74.25MHz [=0x1D01]
5	1920x1080i	74.25MHz
16	1920x1080p	148.5MHz [=0x3A02]
35 or 36	2880x480p	108.00MHz [=0x2A30]

- …then pixel clock frequency of DTD shall be exactly value shown above.
- If pixel clock frequency of DTD does not exactly match then FAIL

Recommended Test Method

Note that the Recommended Test Equipment (Quantum Data 882CA) can be used to perform all EDID-checking tests simultaneously. This includes all tests in section 8.2 and several tests in 8.5, including this test.

1) If the EDID image has not yet been captured from the Sink:
    2) Connect Sink DUT to Quantum Data 882CA and execute commands to perform HDMI EDID analysis.
    3) If any errors are reported during EDID read then FAIL, “DDC read”.
4) Launch EDID Analysis tool and open the EDID image.
5) Execute EDID Analysis command “HDMI Analysis”.
6) If any errors are reported then FAIL, <error comment>
7) Perform steps in Required Test Method against viewed EDID image
8) PASS/FAIL criteria defined above

Test ID 8-18: HDMI Format Support Requirements

Reference	Requirement
[HDMI: 6.2.1] [Video] Format Support Requirements	"An HDMI Sink that accepts 60Hz video formats shall support the 640x480p @ 59.94/60Hz and 720x480p @ 59.94/60Hz video format timings." "An HDMI Sink that accepts 60Hz video formats, and that supports HDTV capability, shall support 1280x720p @ 59.94/60Hz or 1920x1080i @ 59.94/60Hz video format timings." "An HDMI Sink that accepts 50Hz video formats shall support the 640x480p @ 59.94/60Hz and 720x576p @ 50Hz video format timings." "An HDMI Sink that accepts 50Hz video formats, and that supports HDTV capability, shall support 1280x720p @ 50Hz or 1920x1080i @ 50Hz video format timings." "An HDMI Sink that is capable of receiving any of the following video format timings using any other component analog or uncompressed digital video input, shall be capable of receiving that format across the HDMI interface.1280x720p @ 59.94/60Hz, 1920x1080i @ 59.94/60Hz, 1280x720p @ 50Hz, 1920x1080i @ 50Hz"
[861-D: Annex A] Example EDID 18-Byte Detailed Timing Descriptors	<See reference for details.>

Test Objective

Verify that Sink DUT indicates support for all required Video Formats in its EDID.

Required Test Method

Note that the following steps simply examine the EDID for indicated support of the required formats.

Perform the following:

- ❑ If the CDF field Sink_60Hz is 'Y', then perform the following:
  - Examine EDID for an SVD containing video format code 2 or 3.
  - If no SVD contains 2 or 3 then FAIL
  - If the CDF field Sink_HDTV is 'Y', then perform the following:
    - Examine EDID for an SVD containing video format code 4 or 5.
    - If no SVD contains 4 or 5 then FAIL
- ❑ If the CDF field Sink_50Hz is 'Y', then perform the following:
  - Examine EDID for SVD containing video format code 17 or 18 (720x576p @ 50Hz).
  - If no SVD contains 17 or 18 then FAIL
  - If the CDF field Sink_HDTV is "Y", then perform the following:

  - Examine EDID for an SVD containing video format code 19 or 20.
  - If no SVD contains 19 or 20 then FAIL

❑ [Tested Format: 1280x720p @ 59.94/60Hz]

- If CDF field Sink_720p60_Other == 'Y' then:
  - If no SVD contains 4 then FAIL

❑ [Tested Format: 1920x1080i @ 59.94/60Hz]

- If CDF field Sink_1080i60_Other == 'Y' then:
  - If no SVD contains 5 then FAIL

❑ [Tested Format: 1280x720p @ 50Hz]

- If CDF field Sink_720p50_Other == 'Y' then:
  - If no SVD contains 19 then FAIL

❑ [Tested Format: 1920x1080i @ 50Hz]

- If CDF field Sink_1080i50_Other == 'Y' then:
  - If no SVD contains 20 then FAIL

Recommended Test Method

Note that the Recommended Test Equipment (Quantum Data 882CA) can be used to perform all EDID-checking tests simultaneously. This includes all tests in section 8.2 and several tests in 8.5, including this test.

1) If the EDID image has not yet been captured from the Sink:
   2) Connect Sink DUT to Quantum Data 882CA and execute commands to perform HDMI EDID analysis.
   3) If any errors are reported during EDID read then FAIL, "DDC read".
4) Launch EDID Analysis tool and open the EDID image.
5) Execute EDID Analysis command "HDMI Analysis".
6) If any errors are reported then FAIL, <error comment>
7) Perform steps in Required Test Method against viewed EDID image
8) PASS/FAIL criteria defined above

Test ID 8-19: Pixel Encoding Requirements

Reference	Requirement
HDMI: 6.2.3] Pixel Encoding Requirements	"All HDMI Sinks shall be capable of supporting both YC_BC_R 4:4:4 and YC_BC_R 4:2:2 pixel encoding when that device is capable of supporting a color-difference color space from any other component analog or digital video input." "If an HDMI Sink supports either YC_BC_R 4:2:2 or YC_BC_R 4:4:4 then both shall be supported."
[HDMI: 8.3.4] Audio and Video Details	"A Sink may indicate support for YC_BC_R pixel encodings. To indicate support, bits 4 and 5 of byte 3 of the EDID Timing Extension shall both be set to one (see Table 29 of CEA-861-D). To indicate no support, bits 4 and 5 shall both be zero."

Test Objective

Verify that Sink supports YC_BC_R pixel encoding when required.

Required Test Method

- [If an HDMI Sink supports either YC_BC_R 4:2:2 or YC_BC_R 4:4:4 then both shall be supported.]
  - Check bits #4 and #5 of byte #3 of the CEA EDID Timing Extension. [861-D: Table 27]
  - If bit # 4 == 1 and bit #5 == 0 then FAIL
  - If bit # 4 == 0 and bit #5 == 1 then FAIL
- [All HDMI Sinks shall be capable of supporting both YC_BC_R 4:4:4 and YC_BC_R 4:2:2 pixel encoding when that device is capable of supporting a color-difference color space from any other component analog or digital video input.]
  - If CDF field Sink_YUV_On_Other == 'Y':
    - Check bits #4 and #5 of byte #3 of the EDID Timing Extension.
    - If either bit is clear (0) then FAIL
- [All HDMI Sinks shall be capable of supporting RGB 4:4:4 pixel encoding.]
  - Transmit 720x480p (if Sink_60Hz = "Y") or 720x576p (if Sink_60Hz = "N") video signal with RGB pixel encoding to Sink DUT.
  - If Sink DUT does not adequately support transmitted video then FAIL
- [If bits #4 or #5 of byte #3 of the EDID Timing Extension are set to one then Sink shall be capable of supporting a YC_BC_R pixel-encoded signal.]
  - Transmit a 720x480p (if Sink_60Hz = "Y") or 720x576p (if Sink_60Hz = "N") signal to Sink DUT using YC_BC_R 4:2:2 pixel-encoding.
  - If DUT does not adequately support transmitted video then FAIL
  - Transmit a 720x480p or 720x576p (depending upon 60Hz/50Hz capability) signal to Sink DUT using YC_BC_R 4:4:4 pixel-encoding.
  - If DUT does not adequately support transmitted video then FAIL

Recommended Test Method

Note that the Recommended Test Equipment (Quantum Data 882CA) can be used to perform all EDID-checking tests simultaneously. This includes all tests in section 8.2 and several tests in 8.5, including the first half of this test.

1) If the EDID image has not yet been captured from the Sink:
    2) Connect Sink DUT to Quantum Data 882CA and execute commands to perform HDMI EDID analysis.
    3) If any errors are reported during EDID read then FAIL (DDC read).
4) Launch EDID Analysis tool and open the EDID image.
5) Execute EDID Analysis command “HDMI Analysis”.
6) If any errors are reported then FAIL
7) For EDID based tests perform steps in Required Test Method against captured EDID image.(PASS/FAIL criteria is defined above).

8) Connect Sink DUT to TMDS Signal Generator
9) Transmit 720x480p (if Sink_60Hz = “Y”) or 720x576p (if Sink_60Hz = “N”) video signal with RGB pixel encoding to Sink DUT.
10) If Sink DUT does not adequately support transmitted video then FAIL
11) If bits #4 or #5 of byte #3 of the EDID Timing Extension are set to one then:
    12) Transmit a 720x480p (if Sink_60Hz = “Y”) or 720x576p (if Sink_60Hz = “N”) signal to Sink DUT using YC_BC_R 4:2:2 pixel-encoding.
    13) If Sink DUT does not adequately support the transmitted video then FAIL
    14) Transmit a 720x480p (if Sink_60Hz = “Y”) or 720x576p (if Sink_60Hz = “N”) signal to Sink DUT using YC_BC_R 4:4:4 pixel-encoding.
    15) If Sink DUT does not adequately support the transmitted video then FAIL

Test ID 8-20: Video Format Timing

Reference	Requirement
[861-D: 4] Video Formats and Waveform Timings	<See reference for details.>

Test Objective

Verify that Sink supports required variations on mandatory video formats and CEA video formats indicated in EDID.

Required Test Method

Connect the Audio/Video Protocol Generator to the Sink DUT.

For each tested format and pixel clock frequency, configure the TMDS Signal Generator to generate a test pattern in the given format at the tested pixel clock frequency. The test pattern should permit the operator to determine if the Sink displays the image with no significant distortions (spurious dots, horizontal or vertical jitter, incorrect colors) and in the expected aspect ratio and position.

All CEA video formats listed in the EDID must be tested at two different pixel clock frequencies. The two different frequencies are the minimum and maximum permitted by a Source. For 50Hz formats, these values are 49.75Hz and 50.25Hz (50Hz ± 0.5%). For 59.94Hz or 60Hz formats, these frequencies are 59.64Hz (59.94Hz – 0.5%) and 60.3Hz (60Hz + 0.5%). The tested pixel clock frequency accuracy must be ±0.05%.

[Verify that Sink DUT supports 640x480p. Note that 640x480p is never required to be listed in any EDID structure but the Sink is required to support reception.]

1) Configure the TMDS Signal Generator to transmit 640x480p @ 60Hz to the Sink DUT at the minimum allowable pixel clock frequency.
2) If the Sink DUT does not adequately support format then FAIL, “640x480p, Max”
3) Configure TMDS Signal Generator to transmit 640x480p @ 60Hz to Sink DUT at the maximum allowable pixel clock frequency.
4) If the Sink DUT does not adequately support format then FAIL, “640x480p, Min”

5) For each SVD in the EDID:
    6) If the SVD is 128 or 0 (VIC field is 0) then FAIL, “Illegal SVD”.
    7) If the VIC>59 then WARNING, “SVD beyond CEA-861-D range.”.

    [An HDMI Sink DUT which indicates support for CEA Format 8 or 9 (1440x240p), shall support both variations of the format (22 and 23 vertical blanking lines).]

    8) If tested SVD indicates video formats 8 or 9:
        9) For each of the two timing variations (22 and 23 lines in vertical blanking) of the 1440x240p @ 59.94Hz video format:
            10) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the minimum allowable pixel clock frequency.
            11) If the Sink DUT does not adequately support format then FAIL
            12) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the maximum allowable pixel clock frequency.
            13) If the Sink DUT does not adequately support format then FAIL

    [An HDMI Sink DUT which indicates support for CEA Format 12 or 13 (2880x240p) shall support both variations of this format (22 and 23 vertical blanking lines).]

    14) If tested SVD indicates video formats 12 or 13:
        15) For each of the two timing variations (22 and 23 lines in vertical blanking) of the 2880x240p @ 59.94Hz video format:
            16) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the minimum allowable pixel clock frequency.
            17) If the Sink DUT does not adequately support format then FAIL
            18) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the maximum allowable pixel clock frequency.
            19) If the Sink DUT does not adequately support format then FAIL

[An HDMI Sink DUT which indicates support for CEA Format 23 or 24 (1440x288p) shall support all variations of this format (24, 25 and 26 vertical blanking lines).]

20) If tested SVD indicates video formats 23 or 24:

  21) For each of the three timing variations (24, 25, and 26 lines in vertical blanking) of the 1440x288p @ 50Hz video format:

    22) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the minimum allowable pixel clock frequency.

    23) If the Sink DUT does not adequately support format then FAIL

    24) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the maximum allowable pixel clock frequency.

    25) If the Sink DUT does not adequately support format then FAIL

[An HDMI Sink DUT which indicates support for CEA Format 27 or 28 (2880x288p) shall support all variations of this format (24, 25 and 26 vertical blanking lines).]

26) If tested SVD indicates video formats 27 or 28:

  27) For each of the three timing variations (24, 25, and 26 lines in vertical blanking) of the 2880x288p @ 50Hz video format:

    28) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the minimum allowable pixel clock frequency.

    29) If the Sink DUT does not adequately support format then FAIL

    30) Configure the TMDS Signal Generator to transmit the timing variation to the Sink DUT at the maximum allowable pixel clock frequency.

    31) If the Sink DUT does not adequately support format then FAIL

32) If tested SVD indicates any format other than 1, 8, 9, 12, 13, 23, 24, 27, or 28, perform the following tests:

  33) Configure TMDS Signal Generator to transmit that video format to Sink DUT at the minimum allowable pixel clock frequency.

  34) If the Sink DUT does not adequately support format then FAIL

  35) Configure TMDS Signal Generator to transmit that video format to Sink DUT at the maximum allowable pixel clock frequency.

  36) If the Sink DUT does not adequately support format then FAIL

Recommended Test Method

Perform Required Test Sequence above using a Recommended TMDS Signal Generator.

PASS/FAIL criteria given above.

8.6 Sink – Audio

Test ID 8-21: Audio Clock Regeneration

Reference	Requirement
[HDMI: 7.2] Audio Sample Clock Capture and Regeneration	<See reference for details.>

Test Objective

Verify proper Sink operation with respect to Audio Clock Regeneration.

Required Test Method

[Verify CDF fields.]

- If CDF field Sink_Audio_Input == "N" then
  - Examine DUT for any other analog or digital audio input (e.g. analog RCA jacks, S/PDIF, etc.).
  - If any other audio input is present on DUT, then FAIL
  - Else, PASS (end test)
- If CDF field Sink_Basic_Audio == "N" and CDF field Sink_Audio_Input == "Y" then FAIL
- [Verify audio clock regeneration using minimum N parameter.]
  - Configure the Audio/Video Protocol Generator to transmit a 480p video format (or 576p if 480p is not supported by DUT) with a 48kHz audio sample rate and ACR packets data with ***minimum*** N parameter which is minimum integer value no less than 128*Fs / 1500 and audio sample. A sine wave signal at a frequency of 1kHz with amplitude of –20dBs as the audio test signal should be used. Check produced sound with speakers.
  - Perform listening test
  - If no sound, extraneous sound (e.g. popping or cracking sound), or unnecessary mute (e.g. short term mute, etc) then FAIL
- [Verify audio clock regeneration using maximum N parameter.]
  - Configure the Audio/Video Protocol Generator to transmit a 480p video format (or 576p if 480p is not supported by DUT) with a 48kHz audio sample rate and ACR packets with ***maximum*** N parameter which is maximum integer value no more than 128*Fs / 300 and audio sample data. A sine wave signal at a frequency of 1kHz with amplitude of –20dBs as the audio test signal should be used.
  - Perform listening test
  - If no sound, extraneous sound (e.g. pop or crack sound), or unnecessary mute (e.g. short term mute, etc) then FAIL

Recommended Test Method

[Verify CDF fields.]

1) If CDF field Sink_Audio_Input == "N" then

2) Examine DUT for any other analog or digital audio input (e.g. analog RCA jacks, S/PDIF, etc.).

3) If any other audio input is present on DUT, then FAIL

4) Else, PASS (end test)

5) If CDF field Sink_Basic_Audio == "N" and CDF field Sink_Audio_Input == "Y" then FAIL

6) Connect TPA-P-TDR to HDMI input connector of Sink DUT.

7) Connect Protocol Generator to all TMDS differential pairs on the TPA-P.

8) Configure the Protocol Generator to output the "Minimum N" test signal pattern described above.

9) Power on Sink DUT and verify that tested HDMI input is active.

10) If Sink does not adequately support signal then FAIL

11) Configure the Protocol Generator to output the "Maximum N" test signal pattern described above.

12) Power on Sink DUT and verify that tested HDMI input is active.

13) If Sink adequately supports signal then PASS

Test ID 8-22: Audio Sample Packet Jitter

Reference	Requirement
[HDMI: 7.8.1] Packet Delivery Rules: Audio Sample Packets	"Relative to an ideal constant-frequency clock, the jitter present in the Audio Sample Packet transmission timing shall not exceed one horizontal line period plus a single audio sample period."

Test Objective

Verify that Sink supports Audio Sample Packets with maximum jitter.

Required Test Method

- ❑ If CDF field Sink_Basic_Audio == "N" then PASS (end test)
- ❑ [Verify reception of Audio Sample Packets with maximum jitter.]
- ❑ Transmit HDMI audio/video stream containing the following:
  - Either 480p, 576p, or VGA (640x480p @ 60Hz) with a 48kHz audio sample rate
  - ACR packets contain the recommended N and CTS values per [HDMI: 7.2.3].
  - Audio Sample packet transmission timing has jitter of one horizontal video (total) line time plus the period of 1 audio sample (i.e. 1/Fs).
- ❑ Perform listening test
- ❑ If no sound, extraneous sound (e.g. clacking sound), or unnecessary mute (e.g. short term mute, etc) then FAIL

Recommended Test Method

1) If CDF field Sink_Basic_Audio == "N" then PASS (end test)

2) Connect TPA-P-TDR to HDMI input connector of Sink DUT.
3) Connect TMDS Signal Generator to all TMDS differential pairs on the TPA-P.
4) Configure the TMDS Signal Generator to output test signals described above.
5) Power on Sink DUT and verify that tested HDMI input is active.
6) If Sink adequately supports all tested signals then PASS

Test ID 8-23: Audio Formats

Reference	Requirement
[861-D: 7.5] CEA EDID Timing Extension Version 3	"If audio is supported in the DTV Monitor, as indicated by the basic audio support bit in the Version 3 CEA EDID Timing Descriptor, then CEA short audio descriptors shall be used to declare which (if any) audio formats are supported in addition to basic audio." "If only basic audio is supported, no Short Audio Descriptors are necessary."
[HDMI: 8.3] E-EDID Data Structure	"…it is permitted for a Source to transmit Basic Audio (see Section 7.3) to a Sink that does not indicate support for Basic Audio."

Test Objective

Verify that Sink supports every audio format specified in EDID.

Required Test Method

- ❑ If CDF field Sink_Basic_Audio == "N" then PASS (end test)
- ❑ Transmit HDMI signal with any DUT-supported video format and 2-channel 32kHz PCM signal to Sink DUT. The ATC is not required to test non-PCM formats.
- ❑ If Sink DUT does not adequately support the audio format then FAIL
- ❑ Transmit HDMI signal with 2-channel 44.1kHz PCM signal to Sink DUT
- ❑ If Sink DUT does not adequately support the audio format then FAIL
- ❑ Transmit HDMI signal with 2-channel 48kHz PCM signal to Sink DUT
- ❑ If Sink DUT does not adequately support the audio format then FAIL

Recommended Test Method

1) If CDF field Sink_Basic_Audio == "N" then PASS (end test)
2) Connect TPA-P-TDR to HDMI input connector of Sink DUT.
3) Connect Protocol Generator to all TMDS differential pairs on the TPA-P-TDR.
4) Configure the Protocol Generator to output 640x480p with 2-channel 32kHz PCM signal to Sink DUT
5) If Sink DUT does not adequately support the audio format then FAIL

6) Configure the Protocol Generator to output 640x480p with 2-channel 44.1kHz PCM signal to Sink DUT

7) If Sink DUT does not adequately support the audio format then FAIL

8) Configure the Protocol Generator to output 640x480p with 2-channel 48kHz PCM signal to Sink DUT

9) If Sink DUT does not adequately support the audio format then FAIL

8.7 Sink – Interoperability With DVI

Test ID 8-24: Interoperability With DVI

Reference	Requirement
[HDMI: App. C.1] Requirement for DVI Compatibility	"…all HDMI Sinks shall be compatible with DVI 1.0 compliant sources (i.e. "systems" or "hosts") through the use of a similar cable converter."
[HDMI: App. C.3] HDMI Sink Requirements	"An HDMI Sink, upon power-up, reset or detection of a new source device, shall assume that the source device is limited to the above behavior. Upon the detection of an indication that the source is HDMI-capable, the HDMI Sink shall follow all of the HDMI Sink-related requirements specified in this document."

Test Objective

Verify that Sink DUT can handle required transition from DVI to HDMI mode.

Required Test Method

- Connect Sink DUT to Audio/Video Protocol Generator
- Transmit 720x480p (if Source_60Hz = "Y") or 720x576p (if Source_60Hz = "N"), RGB pixel encoding, no Guard Bands, no Data Islands
- If Sink does not adequately support signal then FAIL

Recommended Test Method

1) Connect Sink DUT to Audio/Video Protocol Generator
2) Configure Audio/Video Protocol Generator to transmit stream with 720x480p (if Source_60Hz = "Y") or 720x576p (if Source_60Hz = "N"), RGB pixel encoding, no Guard Bands, no Data Islands.
3) Turn on Sink DUT and verify that HDMI port is active.
4) Verify that Sink DUT supports signal with correct pixel encoding and no audio.
5) If Sink does not adequately support signal then FAIL

8.8 Sink – Advanced Features

Test ID 8-25: Deep Color

Reference	Requirement
[HDMI: 6.5] Pixel Encoding	<See reference for details.>

Test Objective

Verify that a Deep Color-capable Sink DUT supports Deep Color packing and signaling.

Required Test Method

1) If CDF field Sink_Deep_Color is “N” then SKIP test
2) If CDF field Sink_Max_TMDS_Clock is zero then FAIL
3) For each video format indicated in CDF field Sink_Video_Formats:
    4) If CDF field Sink_DC_36bit is “N” then FAIL, else
        5) Calculate TMDS clock by multiplying base clock rate of video format (27MHz, 74.25MHz or 148.5MHz) by 1.5.
        6) If CDF field Sink_Max_TMDS_Clock is zero or is greater than calculated required clock then:
            7) Configure Audio/Video Protocol Generator to transmit that video format to Sink DUT using 36-bit pixel depth and RGB pixel encoding.
            8) If the Sink DUT does not adequately support format then FAIL
            9) If CDF field Sink_DC_Y444 is “Y” then configure Audio/Video Protocol Generator to transmit that video format to Sink DUT using 36-bit pixel depth and YC_BC_R 4:4:4 pixel encoding.
            10) If the Sink DUT does not adequately support format then FAIL
    11) If CDF field Sink_DC_30bit then
        12) Calculate TMDS clock by multiplying base clock rate of video format (27MHz, 74.25MHz or 148.5MHz) by 1.25.
        13) If CDF field Sink_Max_TMDS_Clock is zero or is greater than calculated required clock then:
            14) Configure Audio/Video Protocol Generator to transmit that video format to Sink DUT using 30-bit pixel depth and RGB pixel encoding.
            15) If the Sink DUT does not adequately support format then FAIL
            16) If CDF field Sink_DC_Y444 is “Y” then configure Audio/Video Protocol Generator to transmit that video format to Sink DUT using 30-bit pixel depth and YC_BC_R 4:4:4 pixel encoding.
            17) If the Sink DUT does not adequately support format then FAIL
    18) If CDF field Sink_DC_48bit then
        19) Calculate TMDS clock by multiplying base clock rate of video format (27MHz, 74.25MHz or 148.5MHz) by 2.

20) If CDF field Sink_Max_TMDS_Clock is zero or is greater than calculated required clock then:

21) Configure Audio/Video Protocol Generator to transmit that video format to Sink DUT using 48-bit pixel depth and RGB pixel encoding.

22) If the Sink DUT does not adequately support format then FAIL

23) If CDF field Sink_DC_Y444 is "Y" then configure Audio/Video Protocol Generator to transmit that video format to Sink DUT using 48-bit pixel depth and YC_BC_R 4:4:4 pixel encoding.

24) If the Sink DUT does not adequately support format then FAIL

25) Repeat for next format

Recommended Test Method

- For each video format indicated in CDF field Sink_Video_Formats:
  - For each color depth indicated in CDF fields Sink_DC_36bit, Sink_DC_30bit, Sink_DC_48bit:
    - For RGB pixel encoding and, if Sink_DC_Y444 then also for YC_BC_R 4:4:4 pixel encoding:
      - Configure Audio/Video Protocol Generator to transmit that video format, that pixel encoding and that color depth to the Sink DUT.
      - Peform Required Test Method using an Audio/Video Protocol Generator that is capable of supporting the tested Deep Color formats and modes.
    - Repeat for next pixel encoding.
  - Repeat for next color depth
- Repeat for next video format

Test ID 8-26: Reserved

Test ID 8-27: High Bitrate Audio

Reference	Requirement
[HDMI: 5.3.11]	<See reference for details on High Bitrate Audio Stream Packet.>
[HDMI: 7.6.2]	<See reference for details on High Bitrate Audio packetization.>

Test Objective

Verify that a High Bitrate Audio-capable sink is able to supports High Bitrate Audio Stream Packets and signaling.

Future Test Method

This test method will be included in a future version of the CTS.

Test ID 8-28: One Bit Audio

Reference	Requirement
[HDMI: 5.3.9]	<See reference for details on One Bit Audio Sample Packet.>
[HDMI: 7.9]	<See reference for details on One Bit Audio.>

Test Objective

Verify that a One Bit Audio-capable sink is able to supports One Bit Audio Packets and signaling.

Future Test Method

This test method will be included in a future version of the CTS.

9 Tests – Repeater

9.1 Repeater Products Overview

Repeaters consist of some number of HDMI input ports and some number of HDMI output ports. Typical HDMI Sink functionality is associated with the input ports and typical Source functionality is associated with the output ports. All input ports shall be fully compliant Sinks and all output ports shall be fully compliant Sources.

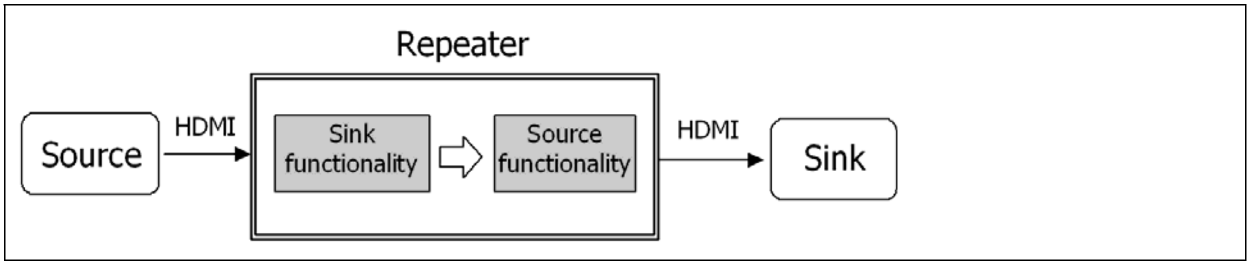


Figure 9-1 Repeater Products Overview

A compliant Repeater will consist of a product where each of the Source functional blocks is compliant with all of the HDMI Source requirements and each of the Sink functional blocks is compliant with all of the HDMI Sink requirements.

9.2 Internal Functional Block Categorization

Within the Repeater product, several functional blocks will be interacting during the transport of the A/V stream from the input port or ports to the output port or ports.

In order to more efficiently test Repeater products, it is useful to understand how these functional blocks interact within the tested product.

9.2.1 Input/Output Categories

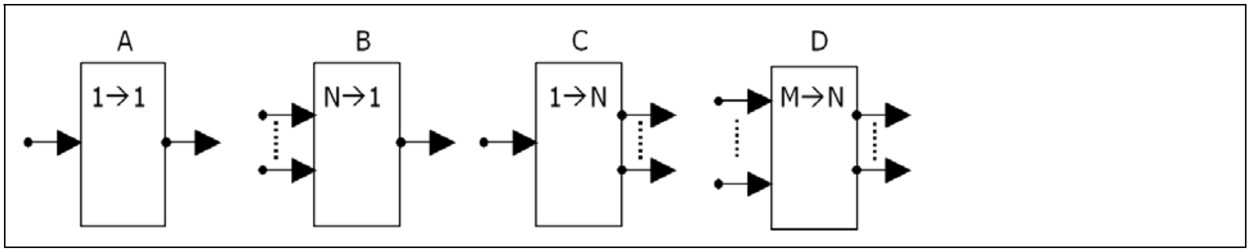


Figure 9-2 Input/Output Categories

Products will fall into several I/O categories:

a) 1→1 Content arriving on one input will be delivered to one output

b) N→1 Content arriving on more than one inputs will be combined in some manner and delivered to one output

c) 1→N Content arriving on one input will be delivered simultaneously to more than one output

d) M→N — Content arriving on more than one input will be combined in some manner and delivered simultaneously to more than one output

9.2.2 Processing Categories

Internally the A/V stream may undergo one or more of the following types of processing:

a) Through — A/V signal passes unmodified from Source to Sink.
EDID passes unmodified from Sink to Source.

b) Convert — A/V signal is converted from format X to format Y. This could be, for instance, a video format conversion from HD to SD.
EDID corresponding to format Y would be present on the Sink and the EDID presented to the Source would include format X.

c) Switch — A single A/V signal is selected from multiple Sources.
EDID from the Sink passes unmodified from Sink to Source.

d) Mix — Multiple A/V signals are mixed. Example: a picture-in-picture function.
EDID from Sink is used for output processing and, depending upon capabilities of the main picture and the sub-picture processing, different EDIDs may be presented to different Sources.

e) Distribute — Single A/V signal is sent, unmodified, to a single selected Sink.
EDID from single Sink passes unmodified to Source.

f) Duplicate — Single A/V signal is passed unmodified to multiple Sinks.
EDID presented to Source may be the intersection of the sets of formats in each of the EDIDs in the multiple Sinks.

g) Exchange — Multiple A/V signals pass from different Sources to different Sinks without any interaction between the streams.
EDIDs presented to Source correspond to Sink destination of that input's stream.

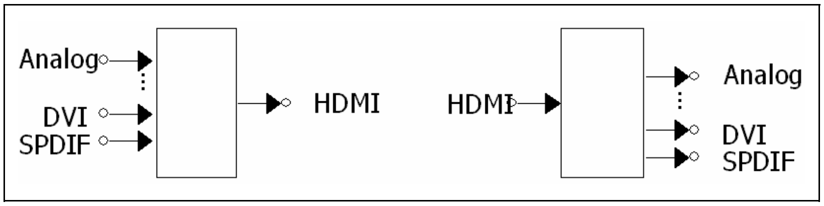
9.2.3 Combinations

The following combinations of functional blocks are possible on each of the different I/O categories.

	Through	Convert	Switch	Mix	Distribute	Duplicate	Exchange
1→1	Y	Y					
N→1	Y	Y	Y	Y			
1→N	Y	Y			Y	Y	
M→N	Y	Y	Y	Y	Y	Y	Y

9.2.4 Non-HDMI I/O

In addition to HDMI input retransmitting to HDMI output functionality, many Repeater products include the ability to source an A/V stream that was delivered to the Repeater on a non-HDMI (analog, DVI or other) input. Likewise, many such products include the ability to forward an A/V stream from an HDMI input to a non-HDMI output.



Such functionality is not addressed in this document.

9.2.5 Source / Sink / Repeater Functionality

Basic Repeater functionality associated with carrying an A/V stream from an HDMI input to an HDMI output is described above.

In addition, many such products also incorporate functions that require them to be tested more extensively.

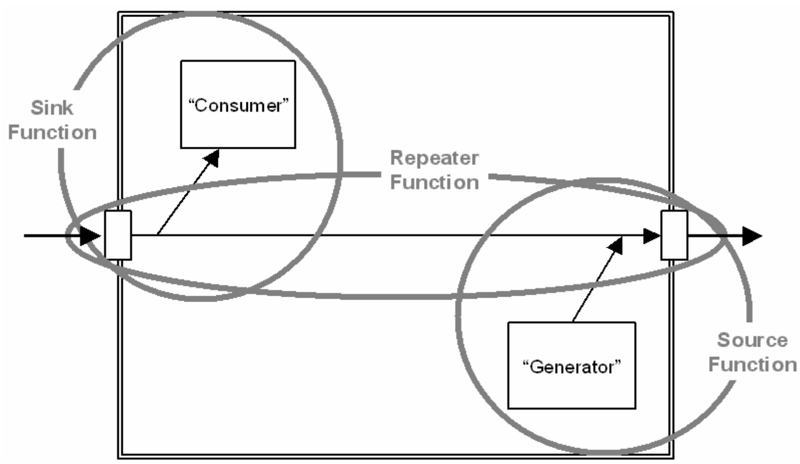


Figure 9-3 Source vs. Sink vs. Repeater Functionality

An example is a Repeater product that effectively acts as a Source product, where the HDMI stream has been "generated" through an internal function such as a DVD player or STB. Likewise, many products act as HDMI Sinks and "consume" the HDMI input stream by displaying it or routing to an audio amplifier for rendering.

HDMI Repeater functionality is tested below. For these tests, the Repeater CDF must be completed to describe the capabilities of the product. In addition, a mini (Source/Sink) CDF is required that describes a subset of the Source and Sink functionality of the product that is related to the Repeater function. This mini-CDF consists of the Source CDF and Sink CDF with many fields already filled-in.

The "generation" and "consuming" functions of a Repeater are tested as a Source and Sink device. For these tests, the normal Source or Sink CDF form must be completed indicating the characteristics of that Source or Sink function.

9.3 Tests of Output Ports

Test ID 9-1: Repeated Output Port

Test Objective

Verify that the HDMI output of an A/V stream from an HDMI input is compliant.

Required Test Method

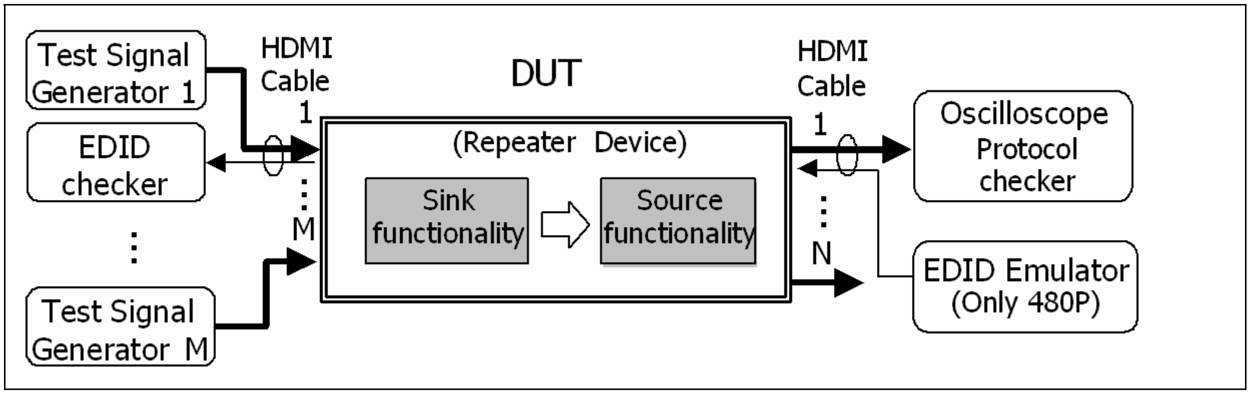


Figure 9-4 Testing of Source Functionality

Perform the following using the "Mini-CDF" form:

1) For each HDMI output port on DUT, do the following:

   2) Determine which HDMI inputs may impact the behavior of the tested HDMI output based on the I/O categorization in CDF field Repeater_IO_Category and the processing categorization indicated in CDF fields Repeater_Through through Repeater_Exchange.

   3) Attach an Audio/Video Protocol Generator that is capable of supporting the highest-TMDS clock rate supported by the DUT to each of the relevant HDMI input ports through a an appropriate cable emulator or long cable to produce an input signal at the highest rate that is close to (but better than) worst-case Sink input eye with data jitter >0.3Tbit.

   4) Add a >50pF capacitor to each of the SCL and SDA signals on this TPA.

   5) Configure the Audio/Video Protocol Generator to generate the "RGB" data pattern (includes 48kHz, 2-channel PCM audio) at the following video format timing:

      - Either 720x480p @ 59.94Hz (if Source_60Hz = "Y") or 720x576p @ 50Hz (if Source_60Hz = "N").

   6) Perform each test case in Section 7, Tests – Source, using the tested port as the HDMI Source DUT.

   7) If any test item FAILs then FAIL

   8) Configure the Audio/Video Protocol Generator to generate the "RGB" data pattern (includes 48kHz, 2-channel PCM audio) at the following video format timing:

      - One of the HDTV formats supported by the product (if any – see CDF field Sink_Video_Formats).

9) Perform each test case in Section 7, Tests – Source, using the tested port as the HDMI Source DUT.

10) If any test item FAILs then FAIL

11) Repeat for each of the HDMI output ports (total count equals CDF field HDMI_output_count)

Test ID 9-2: Source Functionality

Test Objective

Verify that the Source "generator" functionality contained within a Repeater product is compliant.

Required Test Method

If the product contains a "generating" function (described above), then Adopter must complete a full Source CDF describing that function. In addition to the Repeated Port tests above, the following tests are required:

Perform the following using the full Source CDF form describing the tested Source ("generating") function:

1) If CDF field Repeater_Source_Fn is 'Y' then do the following:

   2) For each HDMI output port on DUT, do the following:

      3) Disconnect any upstream HDMI device to ensure that the source function and not the repeater function is being tested.

      4) Perform each test case in Section 7, Tests – Source, using the selected port as the HDMI Source DUT and using the full Source CDF. Do not perform the tests in section 7.3 if they have already been performed under Test ID 9-1.

      5) If any test item FAILs then FAIL

   6) Repeat for each of the HDMI output ports

9.4 Tests of Input Ports

Test ID 9-3: Repeated Input Port

Test Objective

Verify that the HDMI input of a stream that is transported to an HDMI output is compliant.

Required Test Method

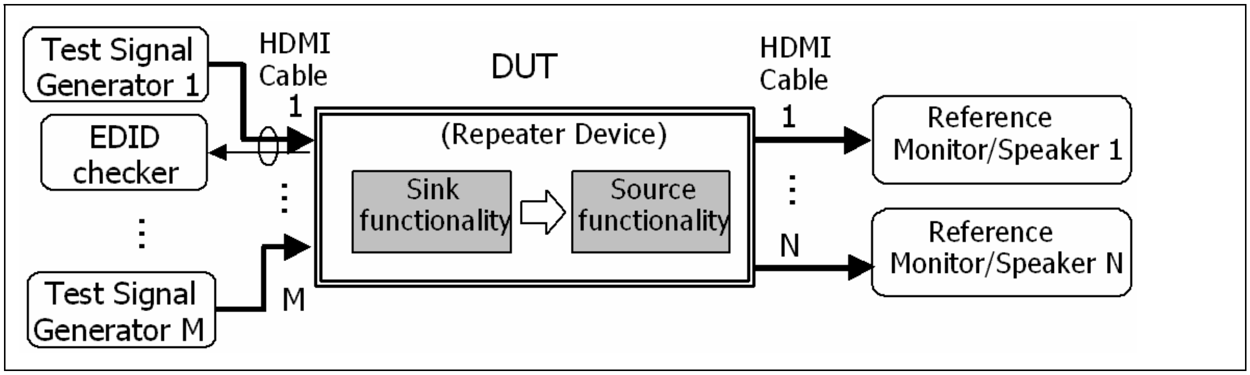


Figure 9-5 Testing of Sink Functionality

Perform the following using the “Mini-CDF” form:

1) For each HDMI input port on DUT, do the following:
    2) Determine which HDMI outputs may be impacted by the tested HDMI input based on the I/O categorization in CDF field Repeater_IO_Category and the processing categorization indicated in CDF fields Repeater_Through through Repeater_Exchange.
    3) Attach a fully-compliant reference HDMI Monitor and Speaker to each relevant HDMI output using an appropriate cable emulator or long cable.
    4) Perform each test case in Section8, Tests – Sink, using the tested port as the HDMI Sink DUT.
        5) Connect and operate required test equipment (analyzers, etc.) to tested port, as specified in each test case.
    6) If any test item FAILs then FAIL
7) Repeat for each of the HDMI input ports (total count equals CDF field HDMI_input_count)

Test ID 9-4: Sink Functionality

Test Objective

Verify that the Sink “consumer” functionality contained within a Repeater product is compliant.

Required Test Method

If the product contains a “consuming” function (described above), then Adopter must complete a full Sink CDF describing that function. In addition to the Repeated Port tests above, the following tests are required:

Perform the following using the full Sink CDF form describing the tested Sink (“consuming”) function:

1) If CDF field Repeater_Sink_Fn is ‘Y’ then do the following:
    2) For each HDMI input port on DUT, do the following:
        3) Disconnect any downstream HDMI device to ensure that the sink function and not the repeater function is being tested.
        4) Perform each test case in Section8, Tests – Sink, using the selected port as the HDMI Sink DUT and using the full Sink CDF. Do not perform the tests in section 8.3 if they have already been performed under Test ID 9-3.
        5) If any test item FAILs then FAIL
    6) Repeat for each of the HDMI input ports

9.5 Tests for Physical Address Handling

Test ID 9-5: Physical Address

Reference	Requirement
[HDMI: 8.7] Physical Address	<See reference for details.>

Test Objective

Verify that Repeater DUT supplies correct Physical Addresses to each of the attached Source devices.

Required Test Method

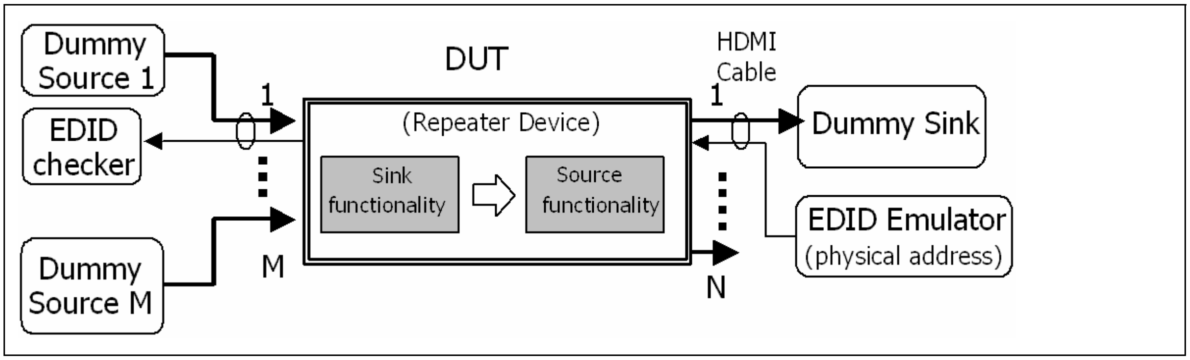


Figure 9-6 Testing of Physical Address Handling

1) If CDF fields Repeater_PA_Copy and Repeater_PA_Increment are both “Y” then FAIL.
2) If CDF fields Repeater_PA_Copy and Repeater_PA_Increment are both “N” then FAIL.
3) Connect the EDID Emulator to the output port which is connected to the CEC signal, specified in CDF field Repeater_CEC_Output.
4) Power on the DUT and verify that all relevant output ports are active.
5) For each (M) of the HDMI input ports (1…N) on the Repeater DUT:
    6) Configure the DUT to select the tested input port (M).
    7) If CDF field Repeater_PA_Copy = “Y” then:
        8) For each of the non-selected HDMI inputs (1 to M-1 and M+1 to N)
            9) Supply +5V Power to the non-selected input port
            10) Check the state of the HPD signal from the non-selected input
            11) If HPD is TRUE then FAIL, “Repeater_PA_Increment used illegally.”
        12) Repeat for next non-selected input
    13) Connect the EDID Reader/Analyzer to the selected input port (M).
        14) For each of the entries in Table 9-1, do the following:
            15) Configure EDID Emulator to supply an EDID image indicating the “Sink Physical Address” shown in the table.

16) Check the state of the HPD signal on the selected input

17) If HPD is FALSE then FAIL

18) Using the EDID Reader/Analyzer, read and analyze the EDID image from the selected input port.

19) Compare the Physical Address read against the appropriate "Source Physical Address" value (based on the CDF fields Repeater_PA_Copy and Repeater_PA_Increment).

20) If the read Source Physical Address does not equal expected value then FAIL

21) Repeat for each of the remaining entries in the table.

22) Repeat for each of the remaining input ports on the DUT.

Table 9-1 Physical Address Test

Sink Physical Address	**Source Physical Address**	
	Repeater_PA_Copy	Repeater_PA_Increment
1.0.0.0	1.0.0.0	1.M.0.0
2.0.0.0	2.0.0.0	2.M.0.0
2.3.0.0	2.3.0.0	2.3.M.0
3.4.5.0	3.4.5.0	3.4.5.M
1.1.1.1	1.1.1.1	F.F.F.F
F.F.F.F	F.F.F.F	F.F.F.F

10 Tests – HDCP

10.1 Overview

All devices capable of performing HDCP operations (CDF field HDCP_Supported) shall be tested for HDCP compliance.

10.2 Test method

HDCP test shall be done according to the HDCP Compliance Test Specification, Revision 1.1, by using the test tool designated by Digital Content Protection, LLC.

Appendix 1 – Authorized Testing Center – Test Equipment List

The following is the equipment used in the Authorized Testing Centers.

Standard ATC Configurations:

TPA Fixtures (1 set)

- (1) Tektronix TPA-P-DI, available as one component in Tektronix 013-A013-50
- (1) Tektronix TPA-P-SE, available as one component in Tektronix 013-A013-50
- (1) Tektronix TPA-P-TDR, available as one component in Tektronix 013-A013-50
- (1) Tektronix TPA-R-DI, available as one component in Tektronix 013-A012-50
- (1) Tektronix TPA-R-SE, available as one component in Tektronix 013-A012-50
- (2) Tektronix TPA-R-TDR, available as one component in Tektronix 013-A012-50
- (2) ADVANTEST TPA-R-NA, part number CAX-ATI013

Digital Oscilloscope (1 set)

- (1) Tektronix TDS7404 4GHz Digital Oscilloscope with:
  - Large memory option (#4M)
    - 32 mega-samples total (16 mega-samples on each of two active channels).
  - Serial pattern trigger option (#ST)

Differential Probe (2 sets)

- (1) Tektronix P7330 Differential Probe
- (1) Tektronix 016-1884-00 Square Pin Adapter
- (1) Tektronix 196-3469-00 Ground Lead

Differential SMA Probe (2 sets)

- (1) Tektronix P7350SMA Differential Probe
- (1) Tektronix 196-3469-00 Ground Lead

Single-Ended Probe (2 sets)

- (1) Tektronix P7240 Single-Ended Probe
- (1) Tektronix 016-1773-00 Square pin socket

SMA Cables (1 set)

- ❑ (10) Tektronix 174-1428-00 (1.5 meter)
- ❑ (4) Tektronix 174-1341-00 (1 meter)

50Ω SMA Terminators (1 set)

- ❑ (14) 50Ω SMA Terminators

Network Analyzer (1 set)

- ❑ (1) ADVANTEST R3860A
  - (1) ADVANTEST R17051 (Auto Cal Kit)
- ❑ Agilent E5071C : ENA Series Network Analyzer
  - Agilent E5071C option 480 : 4-port Test Set, 9 kHz to 8.5 GHz
  - Agilent N4431B : 4-port RF E-Cal module

The following test equipment is currently being used in the ATC under evaluation:

- ❑ ADVANTEST R3768-0400-1010

TDR/TDT Oscilloscope (1 set)

- ❑ (1) Tektronix TDS8200B
- ❑ (1) Tektronix 80E04 TDR-module
- ❑ (1) Tektronix 80E03 Sampling module

DC Source/Meter and Probe (1 set)

- ❑ (1) ADVANTEST R6240A

Digital Multi-Meter (1 set)

- ❑ (1) ADVANTEST R6552

Resistor for HPD Test (1 set)

- ❑ (1) For Sink Testing; 10kΩ
- ❑ (1) For Source Testing; 1.2kΩ

DC power supply (1 set)

- ❑ (1) KENWOOD PW18-1.8AQ

Digital LCR Meter (1 set)

- (1) HIOKI 3522-50 Digital LCR Meter
- (1) HIOKI 9143 Probe
- (1) HIOKI 9268 DC Bias unit

HDMI Cable Emulator (1 set)

- Type 1
  - Category 1: Agilent E4887A-101
- Type 2
  - 27MHz: JAE DC1P19ST02700AA
  - 75MHz: JAE DC1P19ST07425AA

EDID Reader/Analyzer + EDID Emulator (1 set)

- Quantum Data 882CA with latest evaluation software

I^{2}C Analyzer (1 set)

- (1) Yokogawa DL1640/F5 Oscilloscope (includes I^{2}C Analyzer option)

Jitter/Eye Analyzer (1 set)

- (1) Digital Oscilloscope
- (2) Differential Probes
- Tektronix TDSHT3 software

TMDS Signal Generator (1 set)

- (1) Tektronix DTG5274 2.7GHz Digital Timing Generator (DTG)
  - (3) Tektronix DTGM30 output modules for DTG5274
  - (2) Tektronix 012-1503-00 Pin Header SMB 51cm (20in.)
  - (2) Tektronix 015-0671-00 SMB-BNC adapter
- (1) Tektronix AWG710 Arbitrary Waveform Generator
- (2) Mini-circuits ZFBT-4R2GW Bias-Tee
  - (2) SMA (female)-SMA (female) adapters (1 for each Bias-Tee)
  - (2) BNC (female)-SMA (male) adapters (1 for each Bias-Tee)
- (1) TPA-P-TDR (in some test configurations, where driving a Sink directly, see above)
- (1) TPA-R-TDR (in some test configurations, where driving a cable, see above)

- ❑ (10 or 12) SMA Cables: either Tektronix 174-1428-00 (1.5 meters) or Tektronix 174-1341-00 (1 meter), as needed to connect output of equipment to TPA boards and to deliver synchronization signal(s) between AWG and DTG
  - (2, optional) SMA (male)-SMA (male) adapters (1 for each Bias-Tee) may be used in place of an SMA cable to directly connect Bias-Tee to AWG front panel
- ❑ (1) SMA (female)-BNC (male) adapter

Transition Time Converter (1 set)

For use with the Agilent E4887A-007 ParBERT

- 74.25MHz: 450ps Picosecond Pulse Labs 5915-110-450PS
- assorted: 60ps PIcosecond Pulse Labs 5915-110-60PS

For use with the Tektronix DTG5274

- Tektronix 250ps 015-0711-00
  - 74.25MHz 250ps+250ps+250ps

Encoding Analyzer (1 set)

- ❑ (1) Panasonic UITA-1000-based setup, described in section 4.2.4.1

Protocol Analyzer

Uses same Encoding Analyzer described above

Video Timing Analyzer

Uses same Encoding Analyzer described above

Video Picture Analyzer

Uses same Encoding Analyzer described above

Audio Timing Analyzer

Uses same Encoding Analyzer described above

Audio/Video Protocol Generator (1 set)

Uses same TMDS Signal Generator (above).

High-Speed Configurations

In addition to the test equipment above, ATCs that are configured to perform testing at TMDS clock frequencies above 74.25MHz have the following equipment.

TPA Fixtures

- Agilent N1080A Opt H01 TPA-Plug & Opt H03 TPA-Control
  - Agilent N5380A TPA-SMA termination and probe head
- Agilent N1080A Opt H02 TPA-Receptacle & Opt H03 TPA-Control
  - Agilent N5380A TPA-SMA termination and probe head
- EFF-HDMI-TPA-P available from Efficere Technologies as part of set ET-HDMI-TPA-S
- EFF-HDMI-TPA-R / EFF-HDMI-TPA-R-CAL available from Efficere Technologies as part of set ET-HDMI-TPA-S

Digital Oscilloscope (1 set)

- Agilent DSO 80000B >=8GHz Digital Oscilloscope
  - DSO80000-001 1-2M memory
- Tektronix DPO70000 >=8 GHz Oscilloscope (e.g. DPO70804) with option 2XL or Tektronix DSA70000 >=8 GHz Oscilloscope (e.g. DSA70804) (equivalent)

Differential Probe (4 sets)

- Agilent 1169A (12GHz) probe amplifier
  - Agilent N5380A probe head
- Tektronix P7313SMA (13GHz)

Differential SMA Probe (2 sets)

Differential Probe (above) is used.

Single-Ended Probe (2 sets)

- Agilent 1169A
  - Agilent N5380A probe head
- Tektronix P7313SMA (13GHz), configured to perform single-ended measurements.

Jitter/Eye Analyzer (1 set)

- Recommended Digital Oscilloscope #2 (see section 4.2.1.3)
  - Agilent DSO 80000B >8GHz Digital Oscilloscope
    - DSO80000-001 1-2M memory
  - Agilent N5380A probe head + Agilent 1169A
  - Agilent HDMI compliance test software N5399A
- Recommended Digital Oscilloscope #3 (see section 4.2.1.3)

  - Tektronix DPO70804 with option 2XL or Tektronix DSA70804 (equivalent)
  - Tektronix P7313SMA
  - Tektronix TDSHT3 software version 3.3.0

TMDS Signal Generator (1 set)

- ❑ Agilent Configuration:
  - (1) Agilent E4887A-007 TMDS Signal Generator
  - (1) Agilent E4887A-307 Accessory and Cable Kit for E4887A-007 TMDS Signal Generator
  - (2) Agilent E4438 series Signal Generators bandwidth >4GHz
    - Option 504 250kHz - 4GHz
    - Option 601 Internal baseband generator, 8Msa memory with digital bus
  - (8) Picosecond Pulse Labs 5542 Bias-Tee
    - available as part of (1) BIT-HDMI-BTK-0001 Bias-Tee Kit for E4887A-007
  - (1) Agilent E4887A-207 HDMI Frame Generator Software for E4887A-007
  - (1) Agilent Test Automation Software Platform N5990A
    - Option 150 HDMI Electrical High-Speed Sink Test Library
    - Option 250 Interface to N5399A Electrical Source Tests
- ❑ Tekrtronix Configuration:
  - (1) Tektronix DTG5334, 3.4GHz Digital Timing Generator
    - (3) Tektronix DTGM30 output modules
    - (1) Tektronix DTGM32 clock output module
  - (1) AFG or AWG jitter source, either:
    - Tektronix AFG3102 Arbitrary Function Generator (AFG), or,
    - Tektronix AWG710 Arbitrary Waveform Generator (AWG)

(10 or 12) SMA Cables: either Tektronix 174-1428-00 (1.5 meters) or Tektronix 174-1341-00 (1 meter), as needed to connect output of equipment to TPA boards and to deliver signal(s) between AWG, AFG and DTG

Transition Time Converter (1 set)

<u>For use with the Agilent E4887A-007 ParBERT</u>

- 74.25MHz: 450ps Picosecond Pulse Labs 5915-110-450PS
- 148.5MHz: 220ps Picosecond Pulse Labs 5915-110-220PS
- 165MHz: 200ps Picosecond Pulse Labs 5915-110-200PS
- 222.75MHz: 150ps Picosecond Pulse Labs 5915-110-150PS
- 340MHz: 60ps PIcosecond Pulse Labs 5915-110-60PS

<u>For use with the Tektronix DTG5334</u>

- Tektronix 150ps 015-0710-00
- Tektronix 250ps 015-0711-00
- These devices can be configured for configuring the eye to meet the following:
  - 74.25MHz 250ps+250ps+250ps
  - 148.5MHz 250ps
  - 165MHz 150ps+150ps
  - 222.75MHz 150ps
  - 340MHz 0ps

HDMI Cable Emulators

- ❑ Type 1
  - Category 1: Agilent E4887A-101
  - Category 2: Agilent E4887A-102
- ❑ Type 2
  - 27MHz: JAE DC1P19ST02700AA
  - 75MHz: JAE DC1P19ST07425AA
- ❑ Type 3
  - Category 2: Agilent E4887A-103

Protocol Analyzer

- ❑ (1) Agilent N5998A -based setup

Video Timing Analyzer

Use same Protocol Analyzer described above

Video Picture Analyzers

Use same Protocol Analyzer described above

Audio Timing Analyzer

Use same Protocol Analyzer described above

Audio/Video Protocol Generator (1 set)

Use same Protocol Analyzer described above

Appendix 2 – Software CRU Technology

(Informative)

The HDMI specification mandates the Clock Recovery Unit (CRU) utilizing a Phase Locked Loop (PLL) with first order transfer function characteristics, in the measurement of the jitter and the eye diagram[3]. The use of a PLL based CRU implemented in hardware has the drawback that correlation of measurement results is difficult due to differences in vendor specific implementations. There are software PLL techniques that exist to extract clock and timing data from a serial data stream. One such technique uses a time domain convolution integral technique that can address the requirement, however this technique demands very high performance digital processing. The method proposed in this paper shows a more practical and affordable way to satisfy the requirement. [4]

PLL Characteristics

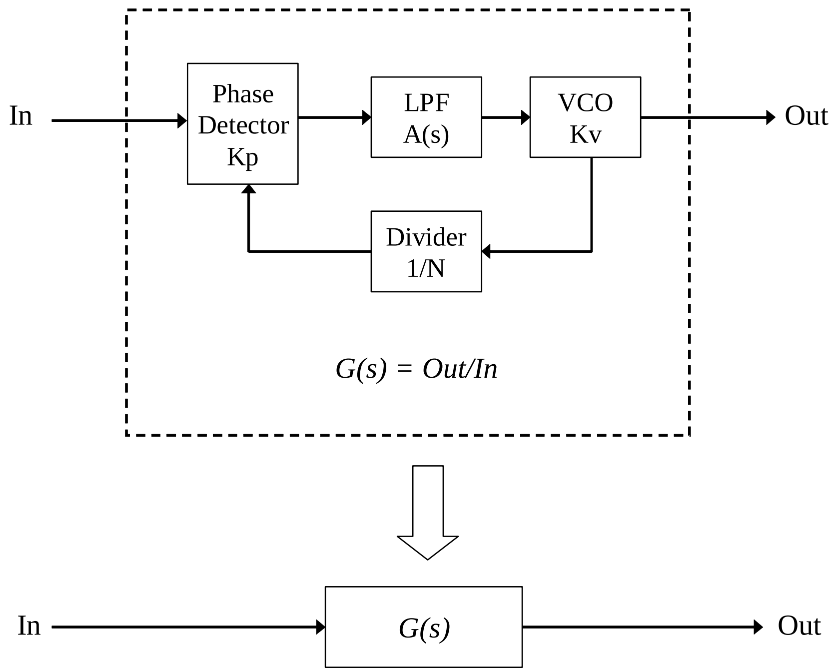


Fig.1 PLL Functional Block

Fig. 1 shows a simplified block diagram of generic phase locked loop (PLL). A PLL consists of the Phase Detector (PD), Low Pass Filter (LPF), Voltage Controlled Oscillator (VCO) and Frequency Divider (FD).

[3] Refer to section 4.2.3 of HDMI Specification Version 1.0

[4] This Technology is provided by Tektronix Inc..

The phase of the input signal is compared to the phase of FD output. The input of the FD is the output of VCO, whose frequency is controlled by the LPF output, which is a filtered form of the PD output. When the phase of FD output is leading compared to the input phase, the PD output changes to decrease the VCO frequency, thus the FD output will lag. Due to the effect of this feedback mechanism, the frequency of VCO is locked to N-times of the input frequency.

As the LPF restricts the quick variation of the incoming signal, high frequency changes in the input phase will be attenuated before being transferred to consecutive functional blocks. Therefore the VCO output represents the average phase of input signal even if the input signal does not have the constant phase rotation i.e. frequency. Using this approach, the PLL circuitry is able to recover the clock information from the modulated input signal.

The transfer function from the input phase to the output phase is represented by following equation:

$$G(s) = \frac{\dfrac{Kp \cdot Kv \cdot H(s)}{s}}{1 + \dfrac{Kp \cdot Kv \cdot H(s)}{s \cdot N}} = \frac{N \cdot Kp \cdot Kv \cdot H(s)}{s \cdot N + Kp \cdot Kv \cdot H(s)}$$

where Kp and Kv are the sensitivity coefficients of PD and VCO respectively, and N is the division factor of FD. H(s) is the transfer function of LPF in the frequency domain.

Assuming N, Kp and Kv are constant, the function G(s) can be simplified as follows:

$$G(s) = \frac{K_2 \cdot H(s)}{s + K_1 \cdot H(s)}$$

It should be noted that G(s) becomes the first order low-pass filter only when H(s) is constant, namely when H(s) is non-dependent on the frequency. This means that H(s) is no longer a low-pass filter in this case. On the contrary, it is well known that the PLL will not be stable without low-pass filter in place of H(s). Therefore, the first order transfer function which is required by the HDMI CRU may not be realized by the PLL circuitry shown in Fig.1.

Conventional Method

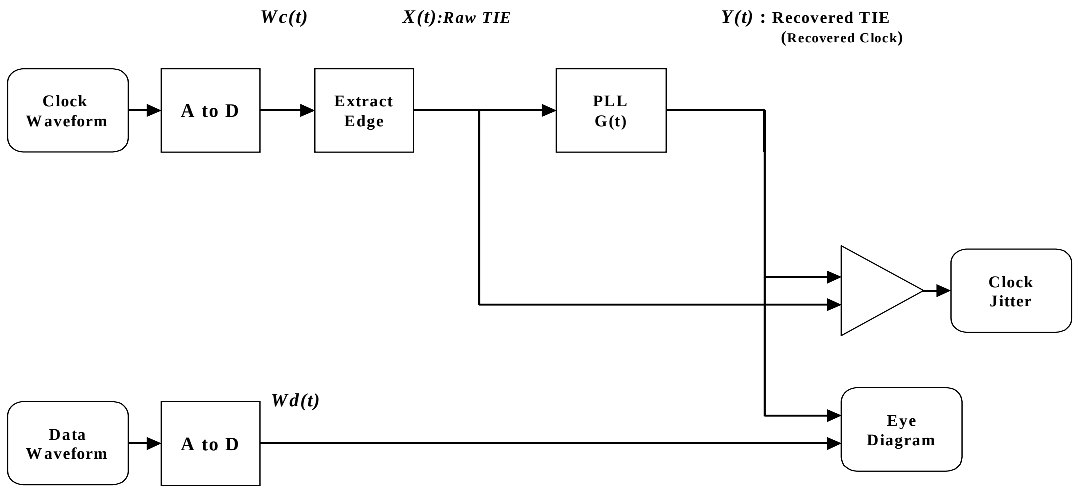


Fig.2 Conventional Clock Recovery Method

Fig. 2 shows a simple PLL design for CRU, measuring clock jitter and eye diagram within a digital oscilloscope. The input signal is first converted to digital information with an A/D converter. The phase of the input signal is extracted by finding the rising (or falling) edges of the digitized signal. A digital simulation of an actual hardware PLL circuit may be realized because the input and output signals exist as just digital information. In this case, the voltage values at several points in the PLL circuit are expressed in the time domain, and are repetitively calculated to derive their time variation. The time interval of the calculation must be sufficiently small in order to retain the high precision of the simulation. Hence, it requires a significant amount of digital processing capability to simulate the actual PLL within a reasonable amount of time.

In this method, the phase transfer function of the PLL is determined by the characteristics of the simulated components. As long as the simulation observes the law of physics, the resultant transfer function does not differ from that of the actual hardware PLL circuit. Given the time to process the data in the simulation, using this method is not advisable. Hence, the first order transfer function to be realized by this method may not be useful too.

Another method to simulate a PLL in software is to use its time domain transfer function from the input phase error to output timing information. The impulse response is used as the time domain transfer function. In this case, given the input signal X(t), the integral operation shown below gives the output signal Y(t).

$$Y(t) = \int_{\tau=-\infty}^{\infty} X(t) \cdot G(\tau - t) d\tau$$

Where G(t) is the time domain representation of G(s) mentioned in the previous section. This is so-called convolution integral. In this case, the input signal is represented as discrete-time samples. The integration above should also be performed in discrete fashion as follows.

$$y(n) = \sum_{m=-\infty}^{\infty} g(m) \cdot x(n-m) = \sum_{m=-\infty}^{\infty} g(n-m) \cdot x(m)$$

There are two disadvantages in time domain convolution method. One is that it still requires a huge number of multiplications and additions to calculate the values of all time points, as easily seen from the form of the equation above. Another is that it is not always practical to express the time domain transfer function as an explicit mathematical representation. In many cases, the human interpretation of the transfer function is made in frequency domain. Some means of conversion is required to derive the time domain response from the frequency domain characteristics. This requirement will complicate the design of the user interface.

It is important to mention that the first order transfer function characteristics can be realized by this convolution method, while it has the difficulties described above. Also important is that this method is inherently stable as far as an appropriate impulse response is adopted, because it does not include any feedback loop.

Proposed Method

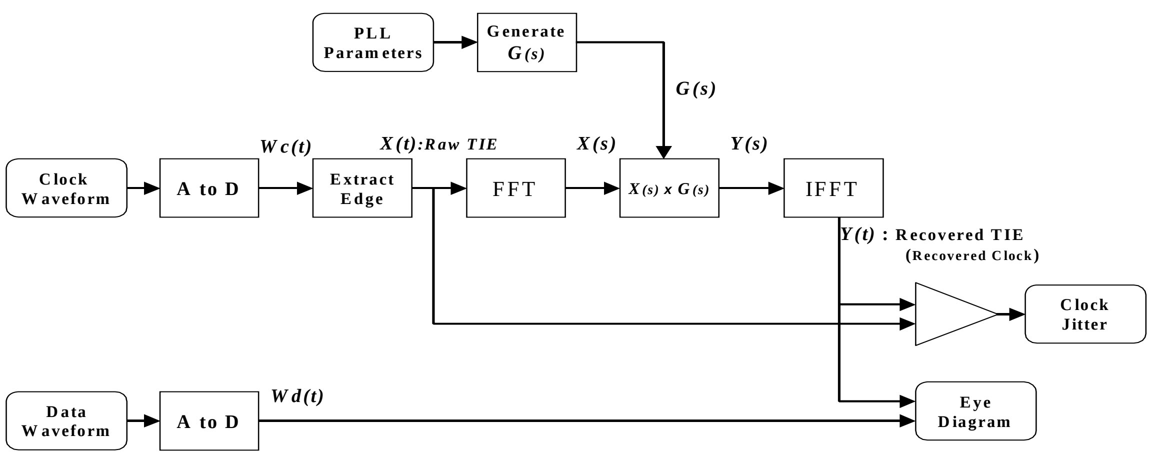


Fig.3 Proposed Clock Recovery Method

The PLL circuitry acts in whole as a low pass filter for incoming time information. In the frequency domain the filter function is simply realized by multiplication of the frequency response coefficients to the input spectrum. The convolution integral in the time domain is equivalent to simple multiplication between frequency-domain functions derived by the well-known Fourier Transform. If the time information and the PLL characteristics are transformed to frequency domain, the PLL processing becomes much easier than in the time domain.

$$Y(s) = G(s) \cdot X(s)$$

As seen in the above equation, the calculation becomes one multiplication (though between complex numbers) per sample point. Hence, it keeps the demand for digital processing performance very low.

After filter function is performed, the time information of the output signal may be derived with inverse transformation. Using FFT algorithm the forward and inverse transformation can be executed in relatively short time compared to simulation in time domain. Thus, the total time to calculate the recovered clock can be significantly reduced.

Jitter Measurement

The jitter of the incoming clock signal is measured by statistically analyzing the time difference between the incoming and recovered clocks. As the timing information of both signals is already retained in digital form, the jitter calculation is simple and straightforward. Usually the peak-to-peak jitter value and the standard deviation (i.e. RMS) jitter value are used for evaluating the signal quality.

$$Jpp = \Delta T \max - \Delta T \min$$

$$J\sigma = \sqrt{\frac{\sum\left(\Delta T_n - \overline{\Delta T}\right)^2}{N}}$$

Appropriate sample points should be chosen to measure the jitter for specific case such as the clock-to-data jitter at the first bit. Such a requirement is addressed by specifying a rectangular area with time range of [–T..+T] and voltage range of [-V..+V].
To obtain an accurate measurement, a large number of samples are required. As the area restriction above reduces the number of measured samples, the capability to process more and more samples is desired. Using the proposed method, it becomes realistic to gather huge amount of statistical information for more precise measurement.

Eye Diagram

An eye diagram is the incoming data waveform repeatedly drawn with the recovered clock used as the time reference. The recovered clock is represented as time information hence it may be used to derive the position where the input data waveform should be drawn. The resulting diagram will precisely indicate the true marginal area with which the reliability of data transmission is determined.

The vertical coordinate to draw the incoming waveform is determined by using the data value itself. To draw the horizontal coordinate (x) is determined by the following equation.

$$Xcoord = Tn - Tref$$

Where, Tn is the time of incoming waveform, and Tref is the time of the reference signal, i.e. the recovered clock signal.

Appendix 3 – Capabilities Declaration Form (CDF)

The following declaration must be completed prior to testing. The options that are supported will be used to determine which groups of tests are performed.

Source/Sink/Repeater Characteristics

Product Category and Info

Field Name	***Field Definition***	***Choices***
Manufacturer	What is the product manufacturer's name?	<any>
Model Name/Number	What is the model name/number of the product?	<any>
HDMI_output_count	How many HDMI output ports are on product?	0…X
HDMI_input_count	How many HDMI input ports are on product?	0…X
HDCP_Supported	Is HDCP supported on this DUT?	Y/N

CEC Characteristics

Field Name	***Field Definition***	***Choices***
CEC_protocol	Is CEC protocol supported? (DUT allocates/supports Physical and Logical addresses, responds to required CEC commands, etc.)	Y/N
Independent_CEC	Are the CEC signals on input connectors independent? (Meaning: no physical connection between inputs and DUT has a logical address of 0 for all inputs). [Note: If device has no HDMI inputs, answer "N".]	Y/N
CEC_root_device	Does the device act as a CEC root device? (Meaning: DUT is a Sink or Repeater and DUT's Physical Address is 0.0.0.0 and DUT's EDID(s) [if present] contain Source Physical Address of P.0.0.0). [Note: If device has no HDMI inputs, answer "N".]	Y/N

Source Characteristics

A copy of the following table must be completed for each of the HDMI output ports on the product (field HDMI_output_count, above). If several ports have identical characteristics, only one of the following needs to be completed for that group or ports. Please indicate which ports are covered by this section.

Which HDMI output ports are covered by this section?	
Is this section part of a mini-CDF meant for Repeater functionality testing?	
Connector Vendor Name:	
Connector Model Name/ID:	

Field Name	***Field Definition***	***Choices***	***Repeater Mini-CDF***
Electrical			
Source_DDC_cap_power-on	Should the DDC capacitance be measured with DUT powered on? (Note: HPD will be false during measurement.)	Y/N	<Adopter fills in field>

Field Name	Field Definition	Choices	Repeater Mini-CDF
Video			
Source_HDMI_YCBCR	Will the product transmit an HDMI video signal using YC_BC_R (4:4:4 or 4:2:2) pixel encoding under some conditions (user selection, EDID indication etc.)?	Y/N	<Fill in>
Source_AVI_Required	Is the product ever required to transmit an AVI InfoFrame?	Y/N	<Fill in>
Source_AVI_Supported	Does the product support the transmission of the AVI InfoFrame under some conditions?	Y/N	<Fill in>
Source_AVI_Info_Available	Is any of the following information available and valid at the Source?: Active Format Aspect Ratio, bar widths, overscan vs. underscan, non-uniform picture scaling, or the colorimetry of the video.	Y/N	N
Source_Alt_Colorimetry	Will the product ever transmit video using a non-default (i.e. alternate) colorimetry under some condition? (e.g. using BT.709 for 480p or BT.601 for 1080i).	Y/N	N
Source_xvYCC	Will the product ever transmit video using xvYCC colorimetry under some condition?	Y/N	N
Source_AR_Converter	Does the product have the ability to convert between aspect ratios of 4:3 and 16:9 (and vice versa)?	Y/N	N
Source_60Hz	Does the product output standard, enhanced or high-definition 60Hz video formats on any video output in addition to 640x480p @ 60Hz?	Y/N	<Fill in>
Source_50Hz	Does the product output standard, enhanced or high-definition 50Hz video formats on any video output?	Y/N	<Fill in>
Source_Above_165	Does the product support any video format/color mode with a TMDS clock frequency above 165MHz?	Y/N	<Fill in>
Source_Deep_Color	Does the product support any Deep Color modes?	Y/N	<Fill in>

Field Name	***Field Definition***	***Choices***	***Repeater Mini-CDF***
Source_Video_Formats	Which HDMI video formats are supported by product and at which color depths? (Select supported items below.)		
	1: 640x480p/60Hz 4:3	not supported (N), 24 bit, 30 bit, 36 bit, and/or 48 bit	N
	2: 720x480p/60Hz 4:3	not supported (N), 24, 30, 36, and/or 48	Y(if 60Hz)
	3: 720x480p/60Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	4: 1280x720p/60Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	5: 1920x1080i/60Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	6: 1440x480i/60Hz 4:3	not supported (N), 24, 30, 36, and/or 48	N
	7: 1440x480i/60Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	16: 1920x1080p/60Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	17: 720x576p/50Hz 4:3	not supported (N), 24, 30, 36, and/or 48	Y(if 50Hz)
	18: 720x576p/50Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	19: 1280x720p/50Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	20: 1920x1080i/50Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	21: 1440x576i/50Hz 4:3	not supported (N), 24, 30, 36, and/or 48	N
	22: 1440x576i/50Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
	31: 1920x1080p/50Hz 16:9	not supported (N), 24, 30, 36, and/or 48	N
Source_Additional Formats	Which other CEA video formats (not listed above) are supported by product?	CEA video format numbers or “none”	None
Source_Non-CEA_Formats	Can the product support formats that are not described in [HDMI 6.3]?	Y/N	N

Field Name	*Field Definition*	*Choices*	*Repeater Mini-CDF*
Source_720p60_Other	1280x720p @ 59.94/60Hz on non-HDMI output? Is DUT capable of transmitting timing above using any component analog or uncompressed digital video output OTHER than the tested port?	Y/N	N
Source_1080i60_Other	1920x1080i @ 59.94/60Hz on non-HDMI output? …supported on output other than tested port?	Y/N	N
Source_480p60_Other	720x480p @ 59.94/60Hz on non-HDMI output? …supported on output other than tested port?	Y/N	N
Source_720p50_Other	1280x720p @ 50Hz on non-HDMI output? …supported on output other than tested port?	Y/N	N
Source_1080i50_Other	1920x1080i @ 50Hz on non-HDMI output? …supported on output other than tested port?	Y/N	N
Source_576p50_Other	720x576p @ 50Hz on non-HDMI output? …supported on output other than tested port?	Y/N	N

Field Name	***Field Definition***	***Choices***	***Repeater Mini-CDF***
Audio			
Source_Basic_Audio	“Basic Audio” supported?	Y/N	Y
Source_PCM_Channels	Max supported L-PCM Channel Count	0, 2…8 channels	2 channels
Source_ Max_Fs_2Ch	L-PCM Maximum Freq for 2-channel audio.	32kHz, 44.1kHz, 48kHz, 88.2kHz, 96kHz, 176.4kHz, or 192kHz	48kHz
Source_ Max_Fs_Multi-Ch	L-PCM Maximum Freq for multi-channel audio.	32kHz, 44.1kHz, 48kHz, 88.2kHz, 96kHz, 176.4kHz, or 192kHz	48kHz
	Under what conditions can above occur	<Media required, signal input required, UI actions, etc.>	Always
Source_NonPCM_Types	Additional audio Coding Types supported	‘None’ or 861-D Table 19 CT values: 0…8	None
	2: AC-3 (Dolby Digital)	Y/N	<Fill in>
	3: MPEG1 (Layers 1 & 2)	Y/N	N
	4: MP3: MPEG1 Layer 3	Y/N	N
	5: MPEG2 (multichannel)	Y/N	N
	6: AAC	Y/N	N
	7: DTS	Y/N	<Fill in>
	8: ATRAC	Y/N	N
	9: One Bit Audio : Note that no tests for One Bit Audio are yet specified in the CTS.	Y/N	N
	10: Dolby Digital +	Y/N	N
	11: DTS-HD	Y/N	N
	12: MAT (e.g. MLP, Dolby TrueHD)	Y/N	N
	13: DST Audio : Note: no tests for One Bit Audio are yet specified in the CTS.	Y/N	N
	14: WMA Pro	Y/N	N

Field Name	Field Definition	Choices	Repeater Mini-CDF
Source_NonPCM_MaxFs	Maximum f_S for non-PCM formats (where f_S = ACR rate)	N/A, 32kHz, 44.1kHz, 48kHz, 88.2kHz, 96kHz, 176.4kHz, or 192kHz	N/A
Source_HBRA	Does DUT support any High Bitrate Audio formats such as Dolby TrueHD (MAT/MLP) or DTS-HD Master Audio?	Y/N	<Fill in>
Source_HBRA_Formats	If Y, then which formats are supported?	Dolby TrueHD, DTS-HD MA, other (enter a specific name)	<Fill in>
Source_One_Bit_Audio	Does DUT support One Bit Audio (e.g. SuperAudio CD) transmission across this HDMI output?	Y/N	<Fill in>

Sink Characteristics

A copy of the following must be completed for each of the HDMI input ports on the product (field HDMI_input_count, above). If several ports have identical characteristics, only one of the following needs to be completed for that group of ports. Please indicate which ports are covered by this section.

Which HDMI input ports are covered by this section?	
Is this section part of a mini-CDF meant for Repeater functionality testing?	
Connector Vendor Name:	
Connector Model Name/ID:	

Field Name	***Field Definition***	***Choices***	***Repeater Mini-CDF***
Electrical			
Sink_Diff_PowerOn	Does the product require that power be applied when termination impedance is measured?	Y/N	<Adopter fills in field>
Sink_Term_Distance	If Sink_Diff_PowerOn is ‘Y’ then: For an impedance measurement, what is the length that can be correctly measured with power off? The length is defined as the number of nsecs it takes for a pulse to travel from the input connector, begin to reflect from the termination impedance, and travel back to the input connector.	<any number>	<Fill in>
Sink_HPD_True	Besides an active ‘+5V Power’ signal, what *additional* conditions are required for the HPD signal to be TRUE? E.g. If the HPD signal is asserted whenever the +5V Power signal is detected, answer “None”. If the DUT must be powered-on, answer “Power-On”.	<Required condition for HPD to be TRUE>	<Fill in>

Field Name	**Field Definition**	**Choices**	**Repeater Mini-CDF**
Video < For video format support, refer to EDID >			
Sink_Display	Does the device display video?	Y/N	<Fill in>
Sink_Deep_Color	Does the device support Deep Color?	Y/N	<Fill in>
Sink_DC_30bit	Does the device support Deep Color at 30 bits per pixel?	Y/N	<Fill in>
Sink_DC_36bit	Does the device support Deep Color at 36 bits per pixel?	Y/N	<Fill in>
Sink_DC_48bit	Does the device support Deep Color at 48 bits per pixel?	Y/N	<Fill in>
Sink_DC_Y444	Does the device support Deep Color in YCbCr 4:4:4?	Y/N	<Fill in>
Sink_xvYCC	Does the device support xvYCC601 or xvYCC709?	Y/N	<Fill in>
Sink_Above_165	Does the product support any video format/color mode with a TMDS clock frequency above 165MHz?	Y/N	<Fill in>
Sink_PrimaryAR	If the device displays video, what is the primary aspect ratio of display?	4:3, 16:9, other	<Unused, leave blank>
Sink_HDTV	Does the device support HDTV capability?	Y/N	<Fill in>
Sink_YUV_On_Other	Is the product capable of receiving a color-difference color space across any other component analog or digital video interface?	Y/N	<Fill in>
Sink_60Hz	Does the product support standard, enhanced or high-definition 60Hz video formats on any video input in addition to 640x480p @ 60Hz?	Y/N	<Fill in>
Sink_50Hz	Does the product support standard, enhanced or high-definition 50Hz video formats on any video input?	Y/N	<Fill in>
Sink_Video_Formats	Which HDMI “Primary” video format timings are supported by product? (Select supported items below.)		
	1: 640x480p/60Hz 4:3	Y/N	N
	2: 720x480p/60Hz 4:3	Y/N	Y(60Hz)
	3: 720x480p/60Hz 16:9	Y/N	N
	4: 1280x720p/60Hz 16:9	Y/N	N
	5: 1920x1080i/60Hz 16:9	Y/N	N
	6: 1440x480i/60Hz 4:3	Y/N	N

	7: 1440x480i/60Hz 16:9	Y/N	N
	16: 1920x1080p/60Hz 16:9	Y/N	N
	17: 720x576p/50Hz 4:3	Y/N	Y(50Hz)
	18: 720x576p/50Hz 16:9	Y/N	N
	19: 1280x720p/50Hz 16:9	Y/N	N
	20: 1920x1080i/50Hz 16:9	Y/N	N
	21: 1440x576i/50Hz 4:3	Y/N	N
	22: 1440x576i/50Hz 16:9	Y/N	N
	31: 1920x1080p/50Hz 16:9	Y/N	N
Sink_Additional_Formats	Which other CEA video formats (not listed above) are supported by product?	CEA video format #s or “none”	none
Sink_720p60_Other	1280x720p @ 59.94/60Hz on non-HDMI? Is DUT capable of supporting above timing using any component analog or uncompressed digital video output OTHER than the tested HDMI output?	Y/N	N
Sink_1080i60_Other	1920x1080i @ 59.94/60Hz on non-HDMI? Is DUT capable of supporting …on output OTHER than the tested HDMI output?	Y/N	N
Sink_480p60_Other	720x480p @ 59.94/60Hz on non-HDMI? Is DUT capable of supporting …on output OTHER than the tested HDMI output?	Y/N	N
Sink_720p50_Other	1280x720p @ 50Hz on non-HDMI? Is DUT capable of supporting …on output OTHER than the tested HDMI output?	Y/N	N
Sink_1080i50_Other	1920x1080i @ 50Hz on non-HDMI? Is DUT capable of supporting …on output OTHER than the tested HDMI output?	Y/N	N
Sink_576p50_Other	720x576p @ 50Hz on non-HDMI? Is DUT capable of supporting …on output OTHER than the tested HDMI output?	Y/N	N

Field Name	***Field Definition***	***Choices***	***Repeater Mini-CDF***
Audio < For audio format support, refer to EDID >			
Sink_Audio_Input	Can analog or digital audio be carried on any non-HDMI input on the device?	Y/N	Y
Sink_Supports_AI	Does Sink support ACP, ISRC1 or ISRC2 packets?	Y/N	Y
Sink_Basic_Audio	Does Sink support Basic Audio?	Y/N	Y
Other			
Sink_Dual_Link_DVI	Does the product also support dual-link DVI?	Y/N	<Fill in>
Sink_Max_TMDS_Clock	What is the maximum TMDS clock frequency supported by the product?	Any value, e.g. 74.25, 148.5, 222.75, etc.	<Fill in>
	If max frequency is other than 27 and 74.25MHz, what video format and color depth are supported at this max frequency?	e.g. 1600x1200 60Hz, 24-bit	<Unused, leave blank>
Sink_Lipsync_Indicated	Are lipsync latency values indicated in the EDID?	Y/N	<Unused, leave blank>
Sink_Dual_Latencies	Is audio or video latency substantially different when handling interlaced video formats than when handling progressive video formats?	Y/N (N if above field is N)	<Unused, leave blank>
Sink_Video_Latency	What is the “progressive video” video latency indicated in the EDID, in milliseconds?	Any number	<Unused, leave blank>
Sink_Audio_Latency	What is the “progressive video” audio latency indicated in the EDID, in milliseconds?	Any number	<Unused, leave blank>
Sink_Video_I_Latency	What is the “interlaced video” video latency indicated in the EDID, in milliseconds?	Any number	<Unused, leave blank>
Sink_Audio_I_Latency	What is the “interlaced video” audio latency indicated in the EDID, in milliseconds?	Any number	<Unused, leave blank>

Repeater Characteristics

If the Repeater product is capable of carrying an audio or video stream from an input port to an output port, it is required to submit a Source "Mini-CDF" and a Sink "Mini-CDF" for the product as well as the Repeater CDF below. In addition, if the device contains an A/V generating function (such as STB or DVD player) or an A/V consuming function, it is required to complete a Source CDF or a Sink CDF describing those characteristics.

Field Name	***Field Definition***	***Choices***
Categories		
Repeater_Source_Fn	Does the product contain an A/V generating function (such as STB or DVD player)?	Y/N
Repeater_Sink_Fn	Does the product contain an audio or video consuming function, such as a display or an audio amplifier?	Y/N
Repeater_IO_Category	Which I/O category applies to the product?	a, b, c, d
Repeater_Through	Does product include a 'Through' processing block?	Y/N
Repeater_Convert	Does product include a 'Convert' processing block?	Y/N
Repeater_Switch	Does product include a 'Switch' processing block?	Y/N
Repeater_Mix	Does product include a 'Mix' processing block?	Y/N
Repeater_Distribute	Does product include a 'Distribute' processing block?	Y/N
Repeater_Duplicate	Does product include a 'Duplicate' processing block?	Y/N
Repeater_Exchange	Does product include an 'Exchange' processing block?	Y/N

Field Name	Field Definition	Choices
Audio		
Repeater_AudioPass	Audio passed-through Repeater?	Y/N
Repeater_AudioRender	Audio rendered on Repeater? (If Yes, fill out Sink audio handling section above for rendered audio formats)	Y/N
CEC		
Repeater_CEC	Is CEC supported?	Y/N
Repeater_CEC_Output	Which output port is connected to CEC?	<port name or number>
Repeater_PA_Copy	Does Physical Address simply get copied from the Sink to the internal EDID (simple repeater case)?	Y/N
Repeater_PA_Increment	Does Physical Address get incremented for each input port?	Y/N

Cable Assembly Characteristics

Connector Vendor Name:	
Connector Model Name/ID:	

Field Name	***Field Definition***	***Choices***
Cable_Type	Which of the following best describes the cable type: (Plain) Wire: Wire-only construction with no circuit components (neither active nor passive). Passive (Equalized): Wire plus passive circuit components. No active circuit components. Active: Contains active circuit components.	Wire, Passive, Active
Cable_Category	Which HDMI 1.3-defined Cable Category does the cable fall into? Category 1 (supports all frequencies up to 74.25MHz, or, Category 2 (supports all frequencies up to 340MHz).	1, 2
Cable_Unidirectional	For proper operation, does cable require specific end to be connected to Source device?	Y/N

Appendix 4 – Test Results Form

All Source DUT tests are performed for each output connector on a device therefore, a product with multiple output connectors will require the completion and submission of multiple Source DUT Test Results Forms. This holds true for input connectors on Sink products as well.

The testing of the ”Repeater” functionality of Repeater products requires the completion of a Source results form for each output connector and a Sink results form for each input as well as one Sink form for each port tested for “Consumer” and one Source form for “Generator” functionality (See Section 9, Tests – Repeater for details). In addition a Repeater results form is required.

Test Results Form – Source DUT

[Output Port:]

ID	Pass/Fail	Comment
7-1: EDID-Related Behavior		
7-2: TMDS –V_L		V_{L_MAX} = V D0+ = V, D0- = V D1+ = V, D1- = V D2+ = V, D2- = V CK+ = V, CK- = V
7-3: TMDS – V_{OFF}		V_{OFF} (mV) when power disconnected D0+ = D0- = D1+ = D1- = D2+ = D2- = CK+ = CK- = V_{OFF} (mV) in standby D0+ = D0- = D1+ = D1- = D2+ = D2- = CK+ = CK- =
7-4: TMDS – T_{RISE}, T_{FALL}		T_{RISE} T_{FALL} D0: psec (T_{BIT}), psec (T_{BIT}) D1: psec (T_{BIT}), psec (T_{BIT}) D2: psec (T_{BIT}), psec (T_{BIT}) CK: psec (T_{BIT}), psec (T_{BIT})
7-5: <Reserved>	-	- - - Reserved - - -
7-6: TMDS – Inter-Pair Skew		T_{IPSKEW_MAX} = T_{PIXEL} D0-D1: D0-D2: D1-D2:

ID	Pass/Fail	Comment
7-7: TMDS – Intra-Pair Skew		T_{XPSKEW_MAX} = T_{BIT} D0: D1: D2: CK:
7-8: TMDS – Clock Duty Cycle		Clock Duty: Min = % Max = %
7-9: TMDS – Clock Jitter		Clock Jitter = T_{BIT}
7-10: TMDS – Eye Diagram		D Jitter = T_{BIT}
7-11: +5V Power		55mA: V_{5V} = V 0mA: V_{5V} = V
7-12: Hot Plug Detect		V_{HPD}(LOW) = V V_{HPD}(HIGH) = V
7-13: DDC/CEC Capacitance		SDA: C1= pF, C2= pF C_{SOURCE} = pF V_{SDA} = SCL: C1= pF, C2= pF C_{SOURCE} = pF V_{SCL} = CEC: C1= pF, C2= pF C_{SOURCE} = pF V_{CEC} =
7-14: CEC Line Connectivity		
7-15: CEC Line Degradation		
7-16: Legal Codes		
7-17: Basic Protocol		

ID	Pass/Fail	Comment
7-18: Extended Control Period		
7-19: Packet Types		
7-20: Reserved		
7-21: Min Format Support		
7-22: Add'l Format Support		
7-23: RGB to RGB-only Sink		
7-24: YC_BC_R to YC_BC_R Sink		
7-25: Video Format Timing		
7-26: Pixel Repetition		
7-27: AVI InfoFrame		
<Audio Tests>		Tested A/V Format Combinations: 1) Video = Audio = 2) Video = Audio = 3) Video = Audio =
7-28: IEC 60958/IEC 61937		
7-29: ACR		
7-30: Audio Packet Jitter		
7-31: Audio InfoFrame		
7-32: Audio Packet Layout		
7-33: Interoperability With DVI		

ID	Pass/Fail	Comment
7-34: Deep Color		
7-35: Gamut Metadata		
7-36: High Bitrate Audio		
7-37: One Bit Audio		

Test Results Form – Sink DUT

[Input Port:]

The Test Results Form for each Sink DUT port tester also includes an EDID image in both of the following formats:

- Text file or human-readable format in hexadecimal with 16 bytes per line. Preferably this file will be interpreted, in-line, with a software tool such as the Silicon Image EDID Analyzer.
- Binary file in Intel Hex format

ID	Pass/Fail	Comment or Value
8-1: EDID Readable		
8-2: EDID VESA Structure		
8-3 CEA Timing Extension Structure		
8-4 TMDS – Termination Voltage		D0+ = V, D0- = V D1+ = V, D1- = V D2+ = V, D2- = V CK+ = V, CK- = V
8-5: TMDS – Minimum Differential Sensitivity		V_{ICM}=2.9/2.7V : V_{DIFF} (minimum) = mV V_{ICM}=3.3V : V_{DIFF} (minimum) = mV
8-6: TMDS – Intra-Pair Skew		Video Format: TMDS clock: MHz D0: T_{BIT} D1: T_{BIT} D2: T_{BIT} CK: T_{BIT} T_{IPSKEW_MAX}:

ID	Pass/Fail	Comment
8-7: TMDS – Jitter Tolerance		Case 1 (D_Jitter, C_Jitter) = (0.5MHz, 10MHz) TMDS clock: MHz Max D_JITTER: T_{BIT} Max C_JITTER: T_{BIT} TMDS clock: MHz Max D_JITTER: T_{BIT} Max C_JITTER: T_{BIT} TMDS clock: MHz Max D_JITTER: T_{BIT} Max C_JITTER: T_{BIT} Case 2 (D_Jitter, C_Jitter) = (1.0MHz, 7.0MHz) TMDS clock: MHz Max D_JITTER: T_{BIT} Max C_JITTER: T_{BIT} TMDS clock: MHz Max D_JITTER: T_{BIT} Max C_JITTER: T_{BIT} TMDS clock: MHz Max D_JITTER: T_{BIT} Max C_JITTER: T_{BIT}
8-8: TMDS – Differential Impedance		$Z_{DIFF\_THROUGH}$ Z_{DIFF_TERM} D0: min = Ω, max = Ω, Term = Ω D1: min = Ω, max = Ω, Term = Ω D2: min = Ω, max = Ω, Term = Ω CK: min = Ω, max = Ω, Term = Ω

ID	Pass/Fail	Comment
8-9: DDC/CEC Line Capacitance		SDA: C1= pF, C2= pF C_{SINK} = pF SCL: C1= pF, C2= pF C_{SINK} = pF V_{SCL} = CEC: C1= pF, C2= pF C_{SINK} = pF V_{CEC} =
8-10: HPD Output Voltage		+5VP=0.0V : V_{HPD} = V +5VP=4.8V : V_{HPD} = V +5VP=5.1V : V_{HPD} = V
8-11: HPD Output Resistance		V_A = , V_B = , Z_{HPD} = Ω
8-12: +5V Power Max Current		Powered On : A Powered Off : A Unplugged from AC: A
8-13: CEC Line Connectivity		
8-14: CEC Line Degradation		
8-15: Character Synchronization		
8-16: Acceptance of All Valid Packet Types		
8-17: Basic Format Support Requirements		

ID	Pass/Fail	Comment
8-18: HDMI Format Support Requirements		
8-19: Pixel Encoding Requirements		
8-20: Video Format Timing		Failed format: x @ Hz, Failed Min or Max frequency (circle) Failed format: x @ Hz, Failed Min or Max frequency (circle) Failed format: x @ Hz, Failed Min or Max frequency (circle)
8-21: Audio Clock Regen.		
8-22: Sample Packet Jitter		
8-23: Audio Formats		
8-24: Interoperability With DVI		
8-25: Deep Color		

Test Results Form – Repeater DUT

ID	Pass/Fail	Comment
9-1: Repeated Output Port		
9-2: Source Functionality		
9-3: Repeated Input Port		
9-4: Sink Functionality		
9-5: Physical Address		

Test Results Form – Cable Assembly DUT

ID	Pass/Fail	Comment
5-1: Connector Minimum Envelope		
5-2: Wire Assignment		
5-3: TMDS Data Eye Diagram		
5-4: Intra-Pair Skew		$T_{XPSKEW\_MAX} =$ nS = T_{BIT}
5-5: Inter-Pair Skew		$T_{IPSKEW\_MAX} =$ nS = T_{BIT}
5-6: Far End Crosstalk		XFE D0-D1: dB, D1-D2: dB D0-D2: dB, D1-CK: dB D0-CK: dB, D2-CK: dB
5-7: Attenuation		A_{LOW} A_{MID} A_{HIGH} D0: dB, dB, dB D1: dB, dB, dB D2: dB, dB, dB CK: dB, dB, dB
5-8: Differential Impedance		D0: Z_{DIFF_HI} = Ω, Z_{DIFF_LO} = Ω D1: Z_{DIFF_HI} = Ω, Z_{DIFF_LO} = Ω D2: Z_{DIFF_HI} = Ω, Z_{DIFF_LO} = Ω CK: Z_{DIFF_HI} = Ω, Z_{DIFF_LO} = Ω
5-9: Active Cable Basic Functionality		

Test Results Form – Plug & Receptacle

ID	Pass/Fail	Comment
6-1: Connector Mechanical		
6-2: GROUP1 Environmental		
6-3: GROUP2 Mated Mechanical		
6-4: GROUP 3 Insulator Integrity		
6-5: GROUP4 Cable Flexing		
6-6: GROUP 5 Electrostatic		

HDMI Compliance Test Specification

Supplement 1

Consumer Electronics Control

Document Revision History

1.3b 2007/03/05 Added Document Revision History.
Fixed typo: “zero” → “one”, “one” → “zero” (1.1 - 1)

1.3a 2006/11/10 Updated Logical Address names for tuner and playback device (throughout).
Updated “preset” to “service” (throughout).
Editorial corrections (throughout).
Removed unused requirement for programmable timing for Signal Free time (4.1.3.1).
Added explanation concerning the use of CEC Device Bridge TPA-CEC-4R (4.1.3.2).
Added clarification that DUT should only be connected to other devices when indicated (5.1).
Added clarification for testing CEC Switches which are part of a device with other functionality (6.2).
Added negative overshoot allowance on the falling edge of CEC line (7-1).
Removed the duplicated checks for nominal bit periods (8.2-2, -4. –6).
Removed requirement to perform duplicate Framing tests on all HDMI connectors (9).
Removal of duplicated test for Signal Free Time when retrying (9.7).
Clarification that test 9.7-3 only applies if the DUT can send 2 consecutive messages.
Removal of erroneous tests for <Report Physical Address> when DUT has address 15 (10.2.1.2-1 and –2).
Addition of tests at new Playback Device Logical Address (10.2.3-3).
Addition of tests at new Tuner Device Logical Address (10.2.4-4).
Test only one HDMI output (11.1).
Removal of Amplifier Logical Address from these tests; and wait more than 200ms before sending <Active Source> (11.1.1-1, -2).
Update to new <Image View On> and <Text View On> behaviour (11.1.1-3, -4) and removal of tests concerning menu behaviour with <Image View On> and <Text View On> (11.1.1 -5, -6).
Removal of tests with messages coming from address 15 (11.1.1-7 and -8).
Removal of tests to check the TV’s response to <Routing Change> and <Routing Information> (11.1.2) (this is now optional).
<Inactive Source> added (11.1.2-8 and 11.2.2-4).
Standby tests now allow some devices to ignore the messages (11.1.3-2, -3 and 11.2.3-2, -3).
Identification of recording tests with a digital tuner (11.1.4-1, -7 and 11.2.4-2).
Addition of Analogue and External recording tests (11.1.4-2, -3, -4, -10, -11 and 11.2.4-3, -4, -5).
Record On [Own Source] now optional (11.1.4-5, -9 and 11.2.4-6, -7, -8).
Timer Programming added (11.1.5 and 11.2.5).
<Get CEC Version> and <CEC Version> added (11.1.6 and 11.2.6).
Changed parameters in <Tuner Device Status> (11.1.8-1, -2, -3 and 11.2.7-1 to –4, -10 to -14).
Updates to Vendor Specific Commands (11.1.9-2, -3 and 11.2.9-2, -3).
Update to new name for OSD Display feature (11.1.10).
Addition of testing other keys during Device Menu Control (11.1.12-1).

Removal of incorrect address in RC Passthrough (11.1.13-5).
<Give Device Power Status> becomes mandatory (11.1.4-1, -2 and 11.2.14-1, -2).
System Audio Control tests added (11.1.15 and 11.2.15).
Audio Rate Control tests added (11.1.16 and 11.2.16).
Clarification that tests need only be performed if device can become a source (11.2.1-1, -2).
Deck Control parameter names updated (11.2.7).
Missing [Status Request] parameter added (11.2.7-14 to –17).
Missing [Eject] test added (11.2.7-18).
<Select Digital Service> now optional (11.2.8-1, -2, -3).
<Select Analogue Service> added (11.2.8-4, -5, -6).
Missing [Status Request] parameter added (11.2.8-12, -13).
Only test valid user codes for that DUT (11.2.12-7).
Now allowed to react to a <User Control Pressed> even if the <User Control Released> was not received (11.2.12-2).
Clarifications to CEC Switches (11.3).
Updates and clarifications to Invalid Messages (12).
CDF updated.

CECT Table of Contents

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CECT 1 Introduction

CECT 1.1 Purpose and Scope

This document constitutes the specification of procedures, tools and criteria for testing the compliance of devices with the High-Definition Multimedia Interface Specification Version 1.3a Supplement 1 – Consumer Electronics Control.

CECT 1.2 Normative references

HDMI Licensing, LLC. “High-Definition Multimedia Interface, Specification Version 1.3a Supplement 1 - Consumer Electronics Control”, November 1st, 2006.

CECT 2 Definitions

CECT 2.1 Glossary of Terms

<Abort> message	A message with opcode FF, which a device shall always Feature Abort when received as a directly addressed message. The message is ignored when received as a broadcast.

CECT 2.2 Acronyms and Abbreviations

DUT	Device Under Test
TE	Test Equipment

CECT 2.3 General Terminology

The word “send” is used throughout the test specification to indicate a message that shall be sent directly addressed. Where a message shall be broadcast it is explicitly stated.

The term “TV” is used throughout the document and is used to represent any HDMI display device (typically such a device will be a Television).

CECT 3 Overview

The CEC Compliance Test Specification is broken down into the low level protocol tests which every device must adhere to and a set of feature based tests which apply only to devices that support that particular feature. A device that fails any low level tests shall not claim to be CEC compliant. A device that fails a feature test shall not claim to support that feature.

Each set of tests has a reference, in the form of [CEC x.y.z], to the corresponding section within the CEC specification that is being tested

CECT 4 Test Equipment

CECT 4.1 Test Equipment

Much of the test equipment used to test the CEC operation is the same as that defined in the main sections of the HDMI compliance test specification. This section defines only the extra equipment needed for testing the CEC line and protocol.

CECT 4.1.1 Required Capabilities versus Recommended Equipment

As with the rest of the Compliance test specification, each piece of test equipment referenced by the individual test cases is listed below. For each of these, the “Required Test Equipment Capabilities” are described. All equipment used for testing the related attributes shall comply with the requirements listed for that equipment.

In addition, for each of the defined pieces of equipment, specific commercial or custom “Recommended Test Equipment" is described. This is the equipment that is used in the initial HDMI Authorized Test Center and should also, if possible, be used for any self-testing of the related functions. Other configurations and equipment may be used for self-testing, as long as that equipment and the processes used meet all of the stated and implied requirements and permit an equivalent level of testing. It is the Adopter’s responsibility to verify that the substituted equipment and processes are sufficient.

CECT 4.1.2 CEC Electrical Test Equipment

For some tests, a signal generator/analyzer is used to cause a DUT to send messages while an oscilloscope measures electrical characteristics of CEC bus waveforms generated by the DUT. For other tests, a voltmeter measures DC potentials under quiescent conditions - while the breakout box applies various static test loads.

The signal generator/analyzer may have a nominal fixed internal pull-up. Some tests require the strength of this pull-up and (or) the load capacitance to be varied. These tests may be conducted with additional parallel-connected components attached to the CEC bus.

CECT 4.1.2.1 Required Test Equipment

- It shall have modifiable load characteristics.
- It shall have the ability to measure voltage levels under no-load and full-load conditions.
- Test equipment accuracy shall be within ±10% of the maximum limiting value of the pass criteria. Test equipment loads shall never exceed the ranges given in CEC Table 1 under "Measurement Method". Tests are carried out at 25˚C ± 5˚C.
- It shall have the ability to measure the quiescent current when not receiving a message, which is drawn by a DUT's CEC line driver, with power completely removed (i.e. while the DUT is not ON or in Standby mode).
- It shall have modifiable bus high and low voltage levels from 0 - 3.7V.
-

CECT 4.1.2.2 Recommended Test Equipment

- YOKOGAWA DL1640 Digital Oscilloscope
- ADVANTEST R6552 Digital Multi-Meter
- Quantum Data TPA-CEC-R Quiescent Electrical Test Fixture
- Quantum Data TPA-CEC-RR Dynamic Electrical Test Fixture

CECT 4.1.3 CEC Logical Test Equipment

A CEC logical test equipment acts as a sink or a source device for the test configurations detailed in section CECT 5.

The Logical test equipment accepts Capabilities Declaration Form (CDF) values and automatically compiles the suite of tests necessary to certify a particular product model. The logical test equipment then guides the user through all of the test steps in the suite, collects data, and produces a summary report.

CECT 4.1.3.1 Required Test Equipment

- It shall be able to mimic an HDMI device at any logical address 0-15.
- It shall be capable of sending all opcodes (both valid and invalid).
- It shall be capable of sending and receiving all valid frames defined within the CEC specification.
- It shall be capable of measuring the timing of: start bits, data bits (low and high periods), response times to messages, inter-frame gaps and ACK bits.
- It shall have programmable timing for start bits (low and high periods), data bits and ACK bits.
- It shall be capable of sending a message synchronized with an incoming message or event (e.g. in order to win arbitration over the incoming message).
- It shall be capable of taking over individual bits on the bus when a device is transmitting a message.
- It shall have the ability to emulate both root and non-root devices.
- It shall be able to send a directly addressed message to a DUT and monitor bus activity - recording the number of retry attempts and time delays (in nominal bit times) between retries, while withholding either header or data block ACK as the DUT attempts to respond.
- It shall handle messages from a DUT appropriately in the test sequence. For example, the DUT may send <Polling message> and / or <Give Device Power Status> message before sending expected message.

CECT 4.1.3.2 Recommended Test Equipment

The CEC Compliance Test Tool (CEC-CTT), recommended throughout this document, consists of a Quantum Data model 882CA (or equivalent) instrument with a network connection to a host computer running Quantum Data Test Management Environment (TME) software. A CEC compliance test module (CEC-CT module) within the TME accepts Capabilities Declaration Form (CDF) values and automatically compiles the suite of tests necessary to certify a particular product model. CEC-CT module then guides the user through all of the test steps in the suite, collects data, and produces a summary report. CEC Device Bridge TPA-CEC-4R is used in some parts of test with the above mentioned CEC-CTT.

CECT 5 Test Configurations

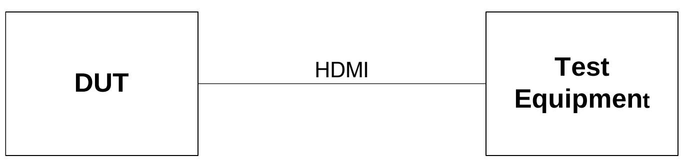
This section describes a set of test configurations used throughout the test specification. In each configuration it is assumed the following (except where explicitly testing that property):

- A source DUT has been allocated a valid physical address by the test equipment. The TE shall allocate address 1.0.0.0 for all source devices except where otherwise defined.
- The DUT has taken an appropriate logical address.
- The DUT is powered on and in an appropriate state to accept the message(s) being tested.

Prior to running any of the recommended tests the CEC Compliance Test Tool instrument should be powered on and communicating with the Test Management Environment software running on the host PC. It is assumed that the CEC Test Tool instrument is in idle mode waiting for a command to be issued from the software.

CECT 5.1 Basic Configuration

The basic configuration consists of one connection between the DUT and the TE. If the DUT has any inputs, then connect the HDMI output of the TE to any input of the DUT. If the device has no inputs, then connect the HDMI input of the test equipment to any output of the DUT.



CECT Figure 1 Basic Configuration

The basic configuration is commonly used throughout the specification. Where no configuration is defined, all tests within that section shall use the basic configuration.

Note: The DUT shall be not connected with a device other than TE if it is not described especially.

CECT 5.2 HDMI Signal Configuration

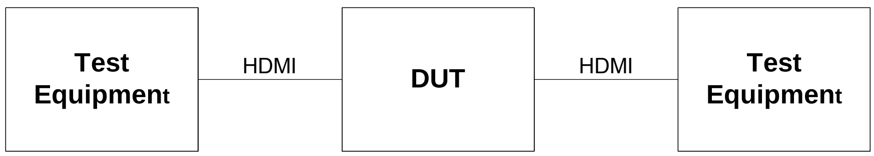
This configuration adds an HDMI signal source to the basic configuration. The TE adds CEC communication to the TMDS signals generated by the HDMI signal source. This configuration is used for testing sink devices only.

CECT Figure 2 HDMI Signal Configuration

The HDMI signal source may reside in the TE. In this case, the basic configuration of CECT section 5.1 is used.

CECT 5.3 Child Connection Configuration

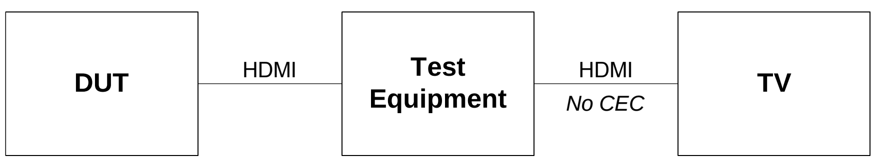
This configuration is used to test a repeater device. The DUT is connected to the TE via an HDMI input and an HDMI output connector. Note that while this configuration shows two conceptual test equipment devices, it may be realized in a single physical device.



CECT Figure 3 Child Connection Configuration

CECT 5.4 Source Device to TV Configuration

This configuration connects a source DUT to a TV via the TE. The TV is used to enable the source device to be easily manipulated, for example to invoke a certain feature via a menu. The TV does not need to support CEC and shall be configured so that it is displaying the DUT. All CEC communication occurs between the DUT and the TE. CEC communication should not be passed through to the TV.



CECT Figure 4 Source Device to TV Configuration

The TE may have an internal or external display, which is not directly attached to the DUT, but that allows the video from the DUT to be monitored. In this case, the basic configuration of CECT section 5.1 is used.

CECT 6 General Constraints

CECT 6.1 Ignoring Messages

In some tests it is a requirement that the DUT ignores an incoming message. In order to pass such a test, the DUT shall not:

- Send any CEC message (including <Feature Abort>) in response.
- Interfere with the CEC bus in any way (other than setting low level acknowledgement bits).
- Invoke any detectable change in its existing mode of operation (e.g. switching play mode).
- Invoke any change in what it is currently displaying (e.g. display an OSD String).

Note that the DUT should still set low-level acknowledgement bits in individual header/data blocks where appropriate.

CECT 6.2 CEC Switches

Devices that act only as CEC Switches shall be treated as a special case within this test specification. The set of tests specified in sections CECT 7, CECT 8 and CECT 9 shall be applied with a minor alteration as detailed below.

Since CEC Switches will not take a logical address, it is not possible to send it an <Abort> message and receive a <Feature Abort> in response. Where a test specifies that this procedure should be carried out it should be replaced with the following:

- Ensure that the DUT has been allocated a physical address of 1.0.0.0.
- Broadcast a <Routing Information> [1.0.0.0] message.

This will invoke the DUT to send a <Routing Information> message, which can then be observed and measured against the relevant test criteria.

A specific section for CEC Switch tests has been created (see CECT 11.3). Devices that combine the functionality of a CEC switch with another device type, shall apply this set of tests in addition to any relevant feature tests.

Note: These conditions are necessary only for pure CEC Switches. If the DUT has other functionality such as the TV or the audio system, it isn't necessary to test as CEC Switch in sections CECT 7, CECT 8 and CECT 9.

CECT 6.3 Handling Flow Control

Because CEC provides a mechanism to enable flow control [CEC 7.2], it is possible that a device may legally reject a message at any time. In the case where a device (unexpectedly) negatively acknowledges a header or data block, the test should be repeated up to 5 times, after allowing a period of at least one second between re-transmissions.

If the DUT continues to negatively acknowledge the message for all retransmission attempts, the test should be logged as a failure.

CECT 7 Electrical Specification

Test ID: CEC7-1 CEC Bus Logic ‘0’ and ‘1’ Voltage Level

Reference	Requirement
[CEC: Table 2] CEC Electrical Specifications	A logic ‘0’ output voltage level must be ≥ 0V and ≤ 600mV.
[CEC: Table 2] CEC Electrical Specifications	A logic ‘1’ output voltage level must be ≥ 2.5V and ≤ 3.63V

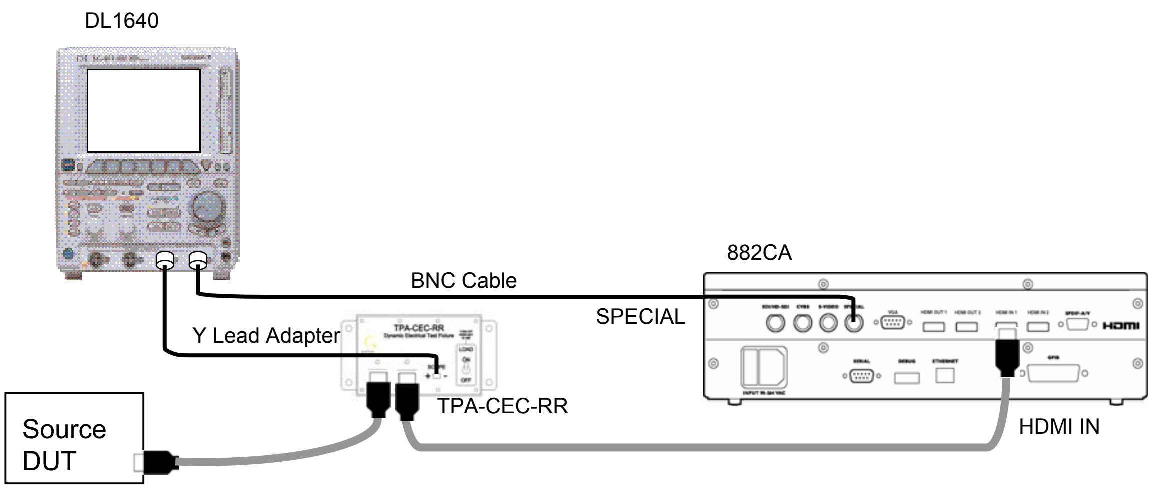
Test Objective

Ensure the DUT CEC line driver Logic '0' and '1' output voltage level is within the limits of the specification.

Required Test Method

- Connect the DUT to the TE.
- Connect CEC line connected to +3.3V via 27Kohm±5% resistor.
- Send the DUT an <Abort> message. The DUT should respond with a <Feature Abort> message
- Measure the waveform that the DUT creates.
- {If logic ‘0’ is < 0V or is > 600mV} or {If logic ‘1’ is < 2.5V or is > 3.63V} then → FAIL
- Repeat test with the CEC line connected to +3.3V via 3Kohm±5% resistor.
- Repeat test with the CEC line connected to ground via 150K+5%-0% resistor.

Recommended Test Method   Test ID: CEC7-1 CEC Bus Logic ‘0’ and ‘1’ Voltage



If the DUT is a sink, then instead connect the HDMI cable to the port marked "HDMI OUT 1" on the 882CA.

Setup 1 Test ID 7-1: CEC Bus Logic ‘0’ and ‘1’ Voltage Level

No.	Description	Recommended TE	Reference	Qty.
1	CEC Compliance Test Tool	Quantum Data 882CA with a host computer	CECT 4.1.3.2	1
2	Digital Oscilloscope	YOKOGAWA DL1640 (*1)		1
3	75ohm BNC-to-BNC Cable	<any>		1
4	75-to-50ohm 5.7dB Loss Pad	<any>		1
5	Dynamic Electrical Test Fixture	Quantum Data TPA-CEC-RR	CECT 4.1.2.2	1
6	HDMI Cable	<any>		2
7	Y Lead Adapter	<any>		1

*1: Tektronix TDS7404 can also be used for the test.

- Set-up the CEC Compliance Test Tool as detailed in section CECT 4.1.3.2
- Power on DUT
- Connect the DUT to the TPA-CEC-RR Dynamic Electrical Test Fixture and the CEC-CTT as detailed in Setup 1.

- Measure the Logic '0' and '1' voltage by following the directions provided by the CEC-CTT for CEC Test ID: 7-1
- The CEC-CTT will indicate if Logic '0' and '1' output voltage levels of CEC driver of DUT is within specifications
- Set the TPA-CEC-RR Dynamic Electrical Test Fixture "LOAD" switch to the ON position1 (Connect CEC line connected to +3.3V via 27Kohm±5% resistor).
  - Setup the special signal output of the 882CA
  - Setup the special signal output of the 882CA
  - Setup the CEC-CTT to emulate either a set-top-box (Tuner) or a DTV.
    - If the DUT is a sink device, then setup the CEC-CTT to emulate a set-top-box
    - Otherwise, if the DUT is a source, then send the CEC-CTT
  - Clear the CEC-CTT 's error queue
  - Command CEC-CTT to send an <Abort> message to the DUT.
  - Query the CEC-CTT to see if any CEC errors occurred
    - If errors occurred, then see if they are related to CEC
    - If any CEC errors occurred (record them and) -> FAIL
  - Record the low and high amplitude displayed on the oscilloscope.
  - If the high amplitude is < 2.5V -> FAIL
  - If the high amplitude is > 3.63V -> FAIL
  - If the low amplitude is < 0V -> FAIL
  - If the low amplitude is > 600mV -> FAIL
  - Repeat test procedure with the TPA-CEC-RR fixture "LOAD" switch in the position 2 (Connect CEC line to +3. 3V% via 3Kohm±5% resistor).
  - Repeat test procedure with the TPA-CEC-RR fixture "LOAD" switch in the position 3 (Connect CEC line to ground via 150K+5%-0% resistor)
  - Return TPA-CEC-RR Dynamic Electrical Test Fixture's LOAD switch to the "OFF" position (to save battery).

Note: During transition from Logic ‘1’ to Logic ‘0’ a negative overshoot with maximum 300mV and up to 150μs duration is allowed

Test ID: CEC7-2 CEC Maximum Rise Time and Fall Time

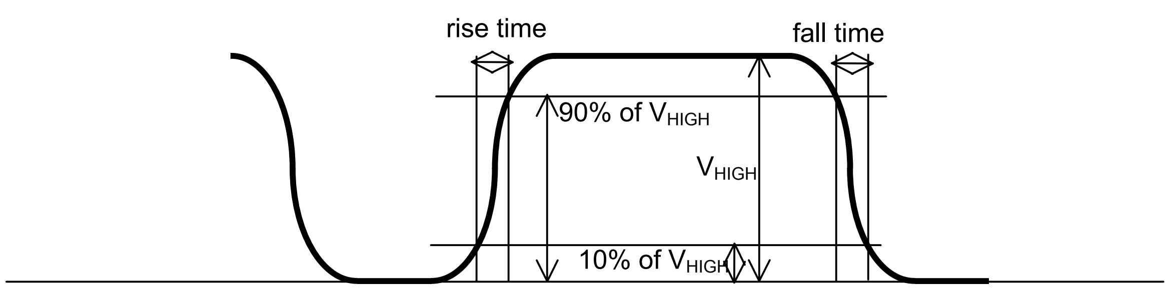
Reference	Requirement
[CEC: Table 2] CEC Electrical Specifications	The rise time from 10% to 90% of the bus pull-up voltage must be ≤ 250µs
[CEC: Table 2] CEC Electrical Specifications	The fall time from 90% to 10% of the bus pull-up voltage must be ≤ 50µs

Test Objective

Ensure the maximum rise time and fall time of the CEC line driver on the DUT is within the limits of the specification.

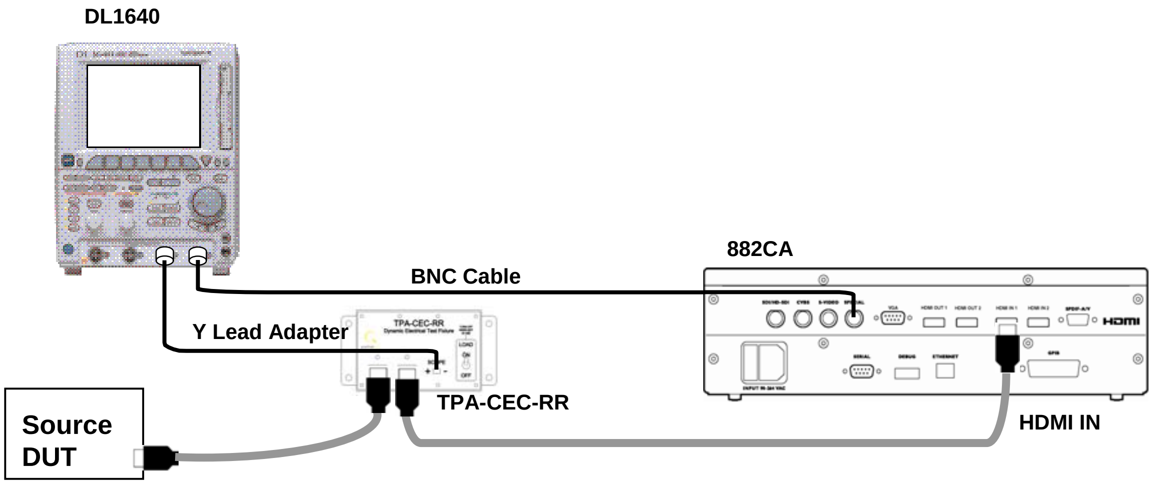
Required Test Method

- Connect TE to CEC line on DUT
- Connect CEC line connected to +3.3V via 27Kohm±5% resistor
- Apply total parasitic capacitance, with value near (but not exceeding) the maximum of 1500pF, from the CEC line to ground
- Measure CEC line voltage, V_{HIGH}
- Send the DUT an <Abort> message. The DUT should respond with a <Feature Abort> message
- Measure the waveform that the DUT creates.
- {If rise time from 10% to 90% of V_{HIGH} > 250µs} and {If fall time from 90% to 10% of V_{HIGH} > 50µs} then → FAIL
- Repeat test with the CEC line connected to +3.3V via 3Kohm±5% resistor and also apply a total parasitic capacitance near the maximum value of 7200pF, from the CEC line to ground.



CECT Figure 5 Rise Time and Fall Time in CEC waveform

Recommended Test Method Test ID: CEC7-2 CEC Maximum Rise Time and Fall Time



If the DUT is a sink, then instead connect the HDMI cable to the port marked "HDMI OUT 1" on the 882CA.

Setup 2.Test ID 7-2: CEC Maximum Rise Time and Fall Time

No.	Description	Recommended TE	Reference	Qty.
1	CEC Compliance Test Tool	Quantum Data 882CA with a host computer	CECT 4.1.3.2	1
2	Digital Oscilloscope	YOKOGAWA DL1640		1
3	75ohm BNC-to-BNC Cable	<any>		1
4	75-to-50ohm 5.7dB Loss Pad	<any>		1
5	Dynamic Electrical Test Fixture	Quantum Data TPA-CEC-RR	CECT 4.1.2.2	1
6	HDMI Cable	<any>		2
7	Y Lead Adapter	<any>		1

*1: Tektronix TDS7404 can also be used for the test

- Set-up the CEC Compliance Test Tool as detailed in section CECT 4.1.3.2.
- Power on DUT.
- Connect the DUT to the TPA-CEC-RR Dynamic Electrical Test Fixture and the CEC-CT T as detailed in Setup 2.
- Measure CEC rise time by following the directions provided by the CEC-CTT for CEC Test ID: 7-2.

- Set the TPA-CEC-RR Dynamic Electrical Test Fixture "LOAD" switch to the position 1.
- Setup the special signal output of the 882CA analyzer.
- Setup the CEC-CTT to emulate either a set-top-box (Tuner) or a DTV.
  - If the DUT is a sink device, then setup the CEC-CTT to emulate a set-top-box.
  - Otherwise, if the DUT is a source, then setup the CEC-CTT to emulate a DTV.
- Clear the CEC-CTT 's error queue.
- Command the CEC-CTT to send an <Abort> message to the DUT.
- Query the CEC-CTT to see if any CEC errors occurred.
  - If errors occurred, then see if they are related to CEC.
  - If any CEC errors occurred -> FAIL
- Record the rise time and fall time displayed on the oscilloscope.
- If the rise time is > 250uS -> FAIL
- If the fall time is > 50uS -> FAIL
- Repeat test with the TPA-CEC-RR Dynamic Electrical Test Fixture's "LOAD" switch in the position 2.
- Repeat test with the TPA-CEC-RR Dynamic Electrical Test Fixture's "LOAD" switch in the OFF position.

- The CEC-CTT will indicate if the rise time and fall time of CEC driver of DUT is within specifications.

CECT 8 Signaling and Bit Timings

CECT 8.1 Bit Transmission

Reference	Requirement
[CEC: 5] Signaling and Bit Timings	The DUT can correctly transmit the individual bits of a CEC message

These tests do not be applied to CEC switches, as they cannot send directly addressed messages.

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1).

If the DUT has any HDMI inputs, then connect an HDMI output of the test equipment to each input of the DUT referring "Number of HDMI Inputs" in CDF.

If the DUT has any HDMI outputs, then connect an HDMI input of the test equipment to each output of the DUT referring "Number of HDMI Outputs" in CDF.

The test equipment can send CEC message. The test equipment monitors the CEC line at the same time.

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
8.1 - 1	Ensure the bit timings of a start bit are within the values specified by CEC.	Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Measure the timing of the ‘start’ bit. Repeat the test at least 3 times.	The start bits low time period is from 3.5ms to 3.9ms. The start bits total time period is from 4.3ms to 4.7ms.

Test ID	Test Objective	Required Test Method	Pass Criteria
8.1 - 2	Ensure the bit timings of a ONE data bit are within the values specified by CEC.	Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Measure the timing of a ONE data bit. Repeat the test at least 3 times.	The ONE data bits low time period is from 0.4ms to 0.8ms. The ONE data bits total time period is from 2.05ms to 2.75ms.
8.1 - 3	Ensure the bit timings of a ZERO data bit are within the values specified by CEC.	Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Measure the timing of a ZERO data bit. Repeat the test at least 3 times.	The ZERO data bits low time period is from 1.3ms to 1.7ms. The ZERO data bits total time period is from 2.05 to 2.75ms.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 8.1.

CECT 8.2 Bit Reception

Reference	Requirement
[CEC: 5] Signaling and Bit Timings	The DUT can correctly receive the individual bits of a CEC message

Configuration

This test shall use the same configuration as CECT 8.1.

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
8.2 - 1	Ensure that the low period receiving tolerances of the start bit are within the values specified.	On the TE set the low interval time of the start bit to 3.5ms and set the total start bit time to 4.5ms. Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Repeat the test for low interval values of 3.7ms and 3.9ms.	The DUT must acknowledge and <Feature Abort> ALL messages within the low interval time range ≥ 3.5 ms and ≤ 3.9 ms.
8.2 - 2	Ensure that the receiving tolerances of the total start bit fall within the values specified.	On the TE set the low interval time of the start bit to 3.7ms and set the high interval time of the start bit to 0.6ms (4.3ms total). Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Repeat the test for high interval values of 1.0ms. (4.7ms total times respectively)	The DUT must acknowledge and <Feature Abort> ALL messages within the total bit time range ≥ 4.3 ms and ≤ 4.7 ms.
8.2 - 3	Ensure that the low period receiving tolerances of a logical ONE data bit fall within the values specified.	On the TE set the low interval time of the ONE bit to 0.4ms and set the total ONE bit time to 2.4ms. Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Repeat the test for low interval values of 0.6ms and 0.8ms.	The DUT must acknowledge and <Feature Abort> ALL messages within the low interval time range ≥ 0.4 ms and ≤ 0.8 ms.

Test ID	Test Objective	Required Test Method	Pass Criteria
8.2 - 4	Ensure that the receiving tolerances of the total logical ONE data bit fall within the values specified.	On the TE set the low interval time of the ONE bit to 0.6ms and set the high interval time of the ONE bit to 1.45ms (2.05ms total). Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Repeat the test for high interval values of 2.15ms. (2.75ms total times respectively)	The DUT must acknowledge and <Feature Abort> ALL messages within the total bit time range ≥ 2.05 ms and ≤ 2.75 ms.
8.2 - 5	Ensure that the low period receiving tolerances of a logical ZERO data bit fall within the values specified.	On the TE set the low interval time of the ZERO bit to 1.3ms and set the total ZERO bit time to 2.4ms. Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Repeat the test for low interval values of 1.5ms and 1.7ms.	The DUT must acknowledge and <Feature Abort> ALL messages within the low interval time range ≥ 1.3 and to ≤ 1.7 ms.
8.2 - 6	Ensure that the receiving tolerances of the logical ZERO data bit fall within the values specified.	On the TE set the low interval time of the ZERO bit to 1.5ms and set the high interval time of the ZERO bit to 0.55ms (2.05ms total). Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Repeat the test for high interval values of 1.25ms. (2.75ms total times respectively)	The DUT must acknowledge and <Feature Abort> ALL messages within the total bit time range ≥ 2.05 ms and ≤ 2.75 ms.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 8.2.

CECT 9 Frame Communication

For all tests in this section the CEC line shall be monitored. A test automatically fails if a device attempts to transmit when it shouldn't or creates any signals on the CEC line that are not expected. For every test where the DUT reacts by sending a CEC message, the test fails if the DUT does not respond within 1 second. [CEC: 9.2]

Reference	Requirement
[CEC: 6] Frame Description [CEC: 7] Reliable Communication Mechanisms [CEC: 8] Protocol Extensions [CEC: 9] CEC Arbitration	The DUT can correctly receive and send a CEC Frame.

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1).

CECT 9.1 ACK (Acknowledge)

[CEC: 6.1.2]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
9.1 - 1	Ensure that the DUT acknowledges with a "0" ACK bit for every message block when receiving a message that is directly addressed to it.	Send an <Abort> message directly addressed to the DUT. If the DUT negatively ACKnowledges any message blocks with a "1" ACK bit (Flow Control) then re-send the message to the DUT after a delay of between 7.2ms and 12ms. Re-send the message up to 5 times.	Every block within the message is acknowledged with a "0" ACK bit. If the DUT does not negatively ACKnowledges any message blocks, then pass the test.
9.1 - 2	Ensure that the DUT acknowledges with a "1" ACK bit for every message block when receiving a message that is directly addressed to another device.	Send an <Abort> message on the bus directly addressed to another device address.	Every block within the message is acknowledged with a "1" ACK bit. (i.e. it does nothing)
9.1 - 3	Ensure that the DUT acknowledges with a "1" ACK bit for every message block when receiving a valid broadcast message.	Broadcast an <Abort> message. If the DUT negatively ACKnowledges any message blocks with a "0" ACK bit (Flow Control) then re-send the message to the DUT after a delay of between 7.2ms and 12ms. Re-send the message up to 5 times.	Every block within the message is acknowledged with a "1" ACK bit. (i.e. it does nothing)

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 9.1.

CECT 9.2 Header Block

[CEC: 6.1.3]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
9.2 - 1	Ensure that the DUT writes the correct Initiator and destination addresses when sending a message. (Does not apply to CEC Switches, as they cannot send directly addressed messages)	For all devices except CEC Switches: Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message.	The DUT writes it's correct logical address in the Initiator address field of the <Feature Abort> message. The DUT writes the value of the previous message's Initiator address (defined by the TE's logical address) in the destination address field of the <Feature Abort> message.
9.2 - 2	Ensure that the DUT writes the correct destination address when broadcasting a message.	For all devices except CEC Switches: Invoke the DUT to send a broadcast message by sending it a <Give Physical Address> message. For CEC Switches: Ensure that the DUT has been allocated a physical address of 1.0.0.0. Broadcast a <Routing Information> [1.0.0.0] message to invoke the DUT to broadcast its own <Routing Information> message.	The DUT sends a message in response and writes the value 15 as the destination address to indicate that the message is broadcast.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 9.2.

CECT 9.3 Retries (Frame Retransmission)

[CEC: 7.1]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
9.3 - 1	Ensure that the DUT handles a no acknowledge response to a directly addressed message where the header is not acknowledged, and tries to re-transmit the message up to 5 times. (Does not apply to CEC Switches, as they cannot send directly addressed messages)	Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Do not acknowledge the header.	The DUT responds to the message with a <Feature Abort>. The DUT tries to re-send the <Feature Abort> message 1-5 times and then stops transmitting the message. The time between the retries is ≥ 3 nominal data bit periods.
9.3 - 2	Ensure that the DUT handles a no acknowledge response to a directly addressed message where the data block is not acknowledged, and tries to re-transmit the message up to 5 times. (Does not apply to CEC Switches, as they cannot send directly addressed messages)	Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. Do not acknowledge a data block within all retransmission attempts.	The DUT responds to the message with a <Feature Abort>. The DUT tries to re-send the <Feature Abort> message 1-5 times and then stops transmitting the message. The time between the retries is ≥ 3 nominal data bit periods.

Test ID	Test Objective	Required Test Method	Pass Criteria
9.3 - 3	Ensure that the DUT will accept a negatively acknowledged response to a broadcast message and tries to re-transmit the message up to 5 times.	Invoke the DUT to broadcast a message as described below: For all devices except CEC Switches: Send a <Give Physical Address> message to the DUT. For CEC Switches: Ensure that the DUT has been allocated a physical address of 1.1.0.0. Broadcast a <Routing Information> [1.1.0.0] message. Negatively acknowledge the header block within the message that the DUT broadcasts. Negatively acknowledge a message block within all retransmission attempts.	The DUT tries to re-send the message between 1-5 times and then stops transmitting the message. The time between the retries is ≥ 3 nominal data bit periods.

Test ID	Test Objective	Required Test Method	Pass Criteria
9.3 - 4	Ensure the DUT can detect low impedance on the CEC line when it is transmitting high impedance and is not expecting a follower asserted bit.	For all devices except CEC Switches: Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. While the DUT is transmitting high impedance during the course of sending the message, modify the bus to low impedance during a non-follower asserted bit. For CEC Switches: Ensure that the DUT has been allocated a physical address of 1.0.0.0. Broadcast a <Routing Information> [1.0.0.0] message. While the DUT is transmitting high impedance during the course of sending the message, modify the bus to low impedance during a non-follower asserted bit.	The DUT tries to re-send the message between 1-5 times and then stops transmitting the message. The time between the retries is ≥ 3 nominal data bit periods.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 9.3.

CECT 9.4 Frame Validation

[CEC: 7.3]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
9.4 - 1	Ensure that for every message that the DUT supports as a follower it ignores the message if it is missing any parameters. (i.e. the message does not contain all operands specified in V1.3a of the CEC specification).	For every message that the DUT supports as a follower and has at least one parameter: Send the message to the DUT missing its final operand of 1 byte or greater. See CECT Table 1 for an example of the messages to be sent.	The DUT ignores the message.

CECT Table 1 Example of frame validation tests

Message	Required Test Method	Pass Criteria
<Active Source>	Send an <Active Source> message to the DUT without the [Physical Address] parameter.	The DUT ignores the message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 9.4

CECT 9.5 CEC Line Error Handling

[CEC: 7.4]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
9.5 - 1	Ensure that when the DUT discovers a corrupted bit it generates a bit error notification.	Send the DUT the <Abort> message. Ensure that Information bit 3 in Figure 6 of CEC6.1 of the first data block contains a corrupted bit. (A period between falling edges that is less than the minimum bit period).	The DUT generates a low bit period on the control signal line of 1.4-1.6 times the nominal data bit period. (A value of $\geq$ 3.4ms and $\leq$ 3.8ms is acceptable). The DUT does not respond to the message. (It does not send a <Feature Abort>).

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 9.5.

CECT 9.6 Control Signal Line Arbitration

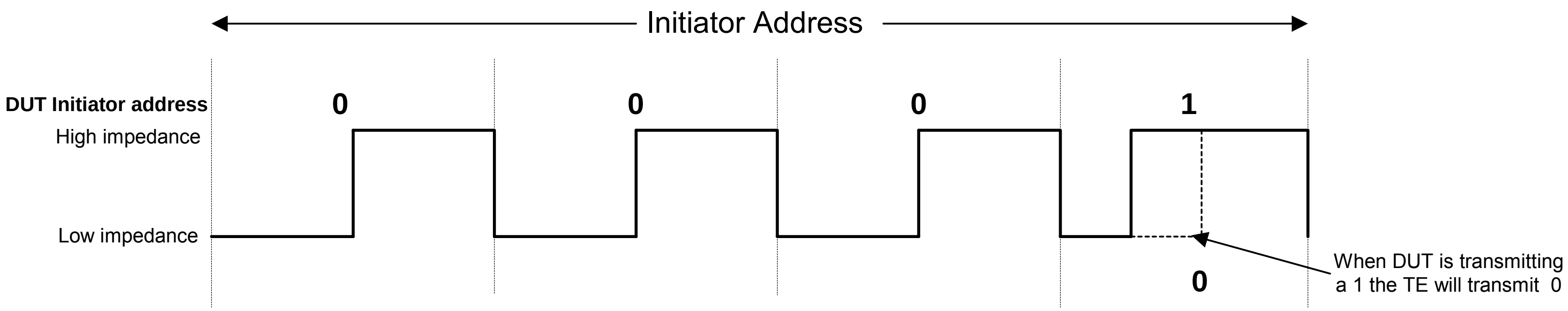
[CEC: 9]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
9.6 - 1	Ensure that if the DUT sees that the bus is low while it is outputting a high level during the start bit, it loses arbitration and stops transmitting.	Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. 3.5ms after the DUT begins transmitting its start bit, transmit a low bit period of 0.8ms, to ensure that the DUT detects the low impedance.	The DUT detects the bus is low, loses arbitration and stops transmitting its current message. When the DUT re-sends its message, it sends after the signal free time of $\geq$ 5 nominal data bit. (It will be PASS if the DUT won't re-send.)

9.6 - 2	Ensure that if the DUT sees that the bus is low while it is outputting a high level during the source address bits, it must lose arbitration, and try to re-transmit after the given signal free time. This test cannot be applied a TV with no outputs, since it will always take logical address 0 and should never lose arbitration to another Initiator address.	If the DUT is a TV with an HDMI output connection then connect it to the TE via its HDMI output connection so it will take logical address 14. Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message. While the DUT is transmitting a 1 in the source address bits, transmit a 0 on the bus. For example Recording Device 1 is address 0b0001 so the TE will take over the final bit of the source address in this case. See CECT Figure 6 for more information.	The DUT detects the bus is low for the taken over source address bit, loses arbitration and stops transmitting its current message. When the DUT re-sends its message, it sends after the signal free time of ≥ 5 nominal data bit periods. (It will be PASS if the DUT won't re-send.)

CECT Figure 6 shows how the DUT loses arbitration in the source address bits. The TE transmits a 0 while the DUT is transmitting a 1.



CECT Figure 6 Example of how the DUT loses arbitration to the TE.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 9.6.

CECT 9.7 Signal Free Time

[CEC: 9.1]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
9.7 - 1	Ensure that the DUT waits for at least 5 bit periods before transmitting a new message.	Send the DUT the <Abort> message. The DUT should respond with a <Feature Abort> message.	The DUT waits for a signal free time of ≥ 5 nominal data bit periods before attempting to transmit the message.
9.7 - 2	Ensure that the DUT waits for at least 7 bit periods before transmitting a message directly after transmitting a previous message (Where applicable). This test only applies if the DUT can send two consecutive messages.	If possible invoke the DUT to send a CEC message and a second CEC message directly afterwards. See CECT Table 2 for the procedure depending upon the device type and features supported. If no device type/feature combinations match the DUT, then this test should be ignored.	The DUT waits for a signal free time of ≥ 7 nominal data bit periods before attempting to transmit the next message.

CECT Table 2 Procedure for sending two consecutive CEC messages

Device Type	Feature Supported	Procedure
Playback Device	One Touch Play	Activate the One Touch Play feature. The device should send an <Image View On> (or <Text View On>) message followed by an <Active Source> message.
Any	Remote Control Pass Through	Activate the Remote Control Pass Through feature. The device should send an <<User Control Pressed> message followed by an <User Control Released> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 9.7.

CECT 10 Device Installation and Addressing

The set of tests for device installation and addressing shall be run on all CEC devices that take a logical address.

CECT 10.1 Physical Address Allocation

Reference	Requirement
[HDMI: 8.7] Physical Address [CEC: 10.1] Physical Address Discovery	A <Report Physical Address> message is sent when required, and that the message indicates the devices correct physical address.

CECT 10.1.1 TV

CECT 10.1.1.1 All TVs

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1) and each input of the DUT shall be connected to an HDMI input of the TE referring "Number of HDMI Inputs" in CDF.

The TV must always take address 0.0.0.0 when it is the only TV in the system.

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.1.1.1 - 1	Ensure that the DUT broadcast the address 0.0.0.0 in a <Report Physical Address> message.	Send a <Give Physical Address> message to the DUT.	The DUT responds by broadcasting a <Report Physical Address> message indicating its address as 0.0.0.0

CECT 10.1.1.2 TVs with an HDMI Output

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1).

Connect the HDMI input of the TE to each output of the DUT (TV) referring "Number of HDMI Outputs" in CDF.

The DUT should take an address allocated by its parent when it is added to a system that already contains a TV as the root device.

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.1.1.2 - 1	Ensure the DUT broadcasts the correct physical address when connected to a system via its HDMI output.	Set the TE to allocate a physical address of 2.0.0.0 to the DUT. Connect the DUT to the TE via its HDMI Output and disconnect (or HPD is asserted from the TE). Set the TE to allocate the DUT a new physical address of 1.0.0.0 to the DUT. Connect the DUT to the TE (or HPD is asserted from the TE).	The DUT broadcasts a <Report Physical Address> [1.0.0.0] message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 10.1.1.1.

CECT 10.1.2 All other devices

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1) and each output of the DUT shall be connected to an HDMI input of the TE referring "Number of HDMI Outputs" in CDF.

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.1.2 - 1	Ensure that the DUT broadcasts the correct physical address when connected directly to the TV.	Set the TE to allocate a physical address of 2.0.0.0 to the DUT. Connect the DUT to the TE via its HDMI Output and disconnect (or HPD is asserted from the TE). Set the TE to allocate a physical address of 1.0.0.0 to the DUT. Connect the DUT to the TE.	The DUT broadcasts a <Report Physical Address> [1.0.0.0] message.
10.1.2 - 2	Ensure that the DUT broadcasts the correct physical address when connected at the bottom of the device network.	Set the TE to allocate a physical address of 1.0.0.0 to the DUT. Connect the DUT to the TE via its HDMI Output and disconnect (or HPD is asserted from the TE). Set the TE to allocate a physical address of 2.3.4.5 to the DUT. Connect the DUT to the TE.	The DUT broadcasts a <Report Physical Address> [2.3.4.5] message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 10.1.2.

CECT 10.2 Logical Address Allocation

Reference	Requirement
[CEC: 10.2] Logical Addressing	The DUT can correctly set its Logical Address

CECT 10.2.1 TV

CECT 10.2.1.1 All TVs

Configuration

This test shall use the Basic Configuration (see CECT Figure 1) and an HDMI input of the DUT shall be connected to an HDMI output of the TE.

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.1.1 - 1	Ensure that the DUT takes the logical address 0 when connected as the root device.	Send a <Polling> message to logical address 0.	The DUT ACKs the polling message.

CECT 10.2.1.2 TV with an HDMI Output

Configuration

This test shall use the Basic Configuration (see CECT Figure 1) and an HDMI output of the DUT shall be connected to an HDMI input of the TE.

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.1.2 - 1	Ensure that the DUT takes the free use address (14) when connected at a physical address other than 0.0.0.0.	Set the TE with a logical address of 0 to allocate a physical address of 2.0.0.0 to the DUT. Connect the DUT to the TE via its HDMI Output and disconnect (or HPD is asserted from the TE). Set the TE to allocate the DUT a physical address of 1.0.0.0. Connect the DUT to the TE (or HPD is asserted from the TE).	The DUT broadcasts a <Report Physical Address> [1.0.0.0] message from logical address 14.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 10.2.1.

CECT 10.2.2 Recording Device

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1) and an HDMI output of the DUT shall be connected to an HDMI input the TE.

The Recording Device addresses are allocated as follows: 1, 2, 9

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.2 - 1	Ensure that the DUT takes the first recording device logical address it queries, when no other recording devices are connected.	Connect the DUT to the TE so that it is allocated a new physical address.	The DUT sends a polling message to a recording device logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.
10.2.2 - 2	Ensure that the DUT takes the second recording device logical address it queries, when one other recording device is connected.	Connect the DUT to the TE so that it is allocated a new physical address. Acknowledge the polling message sent by the DUT.	The DUT sends a polling message to a recording device logical address. The message is acknowledged, so the DUT sends a second polling message to the next recording device logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.2 - 3	Ensure that the DUT takes the third recording device logical address it queries, when two other recording devices are connected.	Connect the DUT to the TE so that it is allocated a new physical address. Acknowledge the first polling message sent by the DUT. Acknowledge the second polling message sent by the DUT.	The DUT sends a polling message to a recording device logical address. The message is acknowledged, so the DUT sends a second polling message to the next recording device logical address. The second message is acknowledged, so the DUT sends a third polling message to the next recording device logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 10.2.2.

CECT 10.2.3 Playback Device

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1) and an HDMI output of DUT shall be connected to an HDMI input the TE.

The Playback Device addresses are allocated as follows: 4, 8, 11

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.3 - 1	Ensure that the DUT takes the first Playback Device logical address it queries, when no other Playback Devices are connected.	Connect the DUT to the TE so that it is allocated a new physical address.	The DUT sends a polling message to a Playback Device logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.
10.2.3 - 2	Ensure that the DUT takes the second Playback Device logical address it queries, when one Playback Device is connected.	Connect the DUT to the TE so that it is allocated a new physical address. Acknowledge the polling message sent by the DUT.	The DUT sends a polling message to a Playback Device logical address. The message is acknowledged, so the DUT sends a second polling message to the next Playback Device logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.
10.2.3 - 3	Ensure that the DUT takes the third Playback Device logical address it queries, when one Playback Device is connected.	Connect the DUT to the TE so that it is allocated a new physical address. Acknowledge the polling message sent by the DUT. Acknowledge the second polling message sent by the DUT.	The DUT sends a polling message to a Playback Device logical address. The message is acknowledged, so the DUT sends a second polling message to the next Playback Device logical address. The message is acknowledged, so the DUT sends a third polling message to the next Playback Device logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 10.2.3.

CECT 10.2.4 Tuner

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1) and an HDMI output of the DUT shall be connected to an HDMI input of the TE.

The Tuner addresses are allocated as follows: 3, 6, 7, 10

Required Test Method

Test ID	**Test Objective**	**Required Test Method**	**Pass Criteria**
10.2.4 - 1	Ensure that the DUT takes the first Tuner logical address it queries, when no other Tuners are connected.	Connect the DUT to the TE so that it is allocated a new physical address.	The DUT sends a polling message to a Tuner logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.4 - 2	Ensure that the DUT takes the second Tuner logical address it queries, when one other Tuner is connected.	Connect the DUT to the TE so that it is allocated a new physical address. Acknowledge the polling message sent by the DUT.	The DUT sends a polling message to a Tuner logical address. The message is acknowledged, so the DUT sends a second polling message to the next Tuner logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.
10.2.4 - 3	Ensure that the DUT takes the third Tuner logical address it queries, when two other Tuners are connected.	Connect the DUT to the TE so that it is allocated a new physical address. Acknowledge the first polling message sent by the DUT. Acknowledge the second polling message sent by the DUT.	The DUT sends a polling message to a Tuner logical address. The message is acknowledged, so the DUT sends a second polling message to the next Tuner logical address. The second message is acknowledged, so the DUT sends a third polling message to the next Tuner logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.4 - 4	Ensure that the DUT takes the forth Tuner logical address it queries, when three other Tuners are connected.	Connect the DUT to the TE so that it is allocated a new physical address. Acknowledge the first polling message sent by the DUT. Acknowledge the second polling message sent by the DUT. Acknowledge the third polling message sent by the DUT.	The DUT sends a polling message to a Tuner logical address. The message is acknowledged, so the DUT sends a second polling message to the next Tuner logical address. The second message is acknowledged, so the DUT sends a third polling message to the next Tuner logical address. The third message is acknowledged, so the DUT sends a third polling message to the next Tuner logical address. The DUT receives no reply so takes that logical address and broadcasts a <Report Physical Address> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 10.2.4.

CECT 10.2.5 Audio Device

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1) and an HDMI output of the DUT shall be connected to an HDMI input of the TE.

An audio device shall take logical address 5

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
10.2.5 - 1	Ensure that the DUT takes logical address 5, when no other audio devices are connected.	Connect the DUT to the TE so that it is allocated a new physical address.	The DUT sends a polling message to address 5. The DUT receives no reply so takes logical address 5 and broadcasts a <Report Physical Address> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 10.2.5.

CECT 11 Feature Tests

Each feature test described below shall only be run for a CEC device that supports that feature.

CDF values are referred to know what device type is being tested also for each feature

Reference	Requirement
[CEC: 12] High Level Protocol [CEC: 13] CEC Features Description [CEC: 15] Message Descriptions [CEC: 16] Message Dependencies [CEC: 17] Operand Descriptions	The DUT correctly supports Mandatory or declared Features and Messages.

CECT 11.1 TV / Display

Configuration

For testing a TV the HDMI Signal Configuration (see CECT 5.2) shall be used, except where explicitly stated otherwise. The test equipment shall by default simulate a device at logical address 1 and send all messages from this address (except where explicitly stated). If the test equipment simulates an Initiator, it shall support retry to send failed message.

Connect the HDMI output of the test equipment to an HDMI input of the DUT (TV).

CECT 11.1.1 One Touch Play

[CEC: 13.1]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.1 - 1	Ensure that the DUT responds to an <Image View On> message coming from various logical addresses.	The following procedure should be repeated with the TE simulating a device at logical addresses 1, 3 and 4. Ensure the DUT is displaying an internal tuner or some other external source. Send the DUT an <Image View On> message. After more than 200msec, Send the DUT an <Active Source> message.	The DUT displays the new source.
11.1.1 - 2	Ensure that the DUT responds to a <Text View On> message coming from various logical addresses.	The following procedure should be repeated with the TE simulating a device at logical addresses 1, 3 and 4. Ensure the DUT is displaying an internal tuner or some other external source. Send the DUT a <Text View On> message. After more than 200msec, Send the DUT an <Active Source> message.	The DUT displays the new source.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.1 - 3	Ensure that the DUT responds to an <Image View On> message when in standby. Test only applies if DUT can be brought out of Standby when receiving an <Image View On> message. See CDF.	Ensure the DUT is in standby. Send the DUT an <Image View On> message.	The DUT powers up.
11.1.1 - 4	Ensure that the DUT responds to a <Text View On> message when in standby. Test only applies if DUT can be brought out of Standby when receiving a <Text View On> message. See CDF.	Ensure the DUT is in standby. Send the DUT a <Text View On> message.	The DUT powers up. .
11.1.1 - 5	Ensure that the DUT broadcasts an <Active Source> message when changing to an internal source from previously displaying an external source. Test only applies if the DUT has an internal source.	Broadcast an <Active Source> [1.0.0.0] message to display external source. Set the DUT to display an internal source (e.g. an internal tuner).	DUT broadcasts an <Active Source> message. (Physical Address 0.0.0.0)
11.1.1 - 6	Ensure that the DUT responds to an <Image View On> message when displaying a text mode. Test only applies if the DUT supports a text display mode such as Teletext.	Ensure the DUT is in text mode (e.g. Teletext) Send the DUT an <Image View On> message.	The DUT removes the text display.
11.1.1 - 7	Ensure that the DUT responds to a <Text View On> message when displaying a text mode. Test only applies if the DUT supports a text display mode such as Teletext.	Ensure the DUT is in a text mode (e.g. Teletext) Send the DUT a <Text View On> message.	The DUT removes the text display.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.1.

CECT 11.1.2 Routing Control

[CEC: 13.2]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.2 - 1	Ensure that the DUT sends a <Set Stream Path> message if the user selects another source device. This test only applies if it is possible to select a source device via the DUT's menu.	Broadcast a <Report Physical Address> [1.1.0.0] message from logical address 3. Broadcast a <Report Physical Address> [1.2.0.0] message from logical address 4. If possible, use the DUT menu to select one of the above registered devices (See CDF for instruction).	The DUT sends a <Set Stream Path> message to the appropriate logical address.
11.1.2 - 2	Ensure that the DUT responds correctly to a <Request Active Source> message when it is not the current active source. This test only applies if the DUT supports <Request Active Source> as Follower (See CDF).	Broadcast an <Active Source> message, indicating that another device is the active source. Broadcast a <Request Active Source> message.	The DUT does not respond to the <Request Active Source> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.2 - 3	Ensure that the DUT responds correctly to a <Request Active Source> message when it is the current active source. This test only applies if the DUT supports <Request Active Source> as Follower (See CDF).	Ensure the DUT is displaying an internal source (e.g. a tuner). Broadcast a <Request Active Source> message.	The DUT responds to the <Request Active Source> message by broadcasting an <Active Source> message.
11.1.2 - 4	Ensure that the DUT accepts <Inactive Source> message. This test is only applies if the DUT supports <Inactive Source> messages as Follower.(See CDF)	Broadcast a <Active Source> [1.0.0.0] message. Send an <Inactive Source> [1.0.0.0] message to the DUT.	The DUT does not send a <Feature Abort> message as a response. (It is manufacturer decision to decide the TV's response.)
11.1.2 - 5	Ensure that the DUT broadcasts a <Routing Change> message when it is manually switched. This test only applies if the DUT has several HDMI inputs that are not independent.	Ensure the DUT is currently switched to child position 1.(i.e. "HDMI Input Port 1")(See CDF for how to switch to child position 1) Switch the DUT manually to child position 2. (i.e. "HDMI Input Port 2")(See CDF for how to switch to child position 2)	The DUT broadcasts a <Routing Change> [1.0.0.0] [2.0.0.0] message

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.2.

CECT 11.1.3 System Standby

[CEC: 13.3]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.3 - 1	Ensure that the DUT broadcasts a correctly formatted <Standby> message when the System Standby feature is initiated.	Invoke the System Standby feature on the DUT. (See CDF for instruction)	The DUT broadcasts a <Standby> message, and switching into standby itself.
11.1.3 - 2	Ensure that the DUT handles a broadcast <Standby> message coming from various logical addresses including the unregistered address. This test only applies if the DUT supports broadcasted <Standby> messages as Follower.	The following procedure should be repeated with the TE simulating a device at logical addresses 1, 3, 4, 5, 13, 14 and 15. Ensure that the DUT is in a state where going into standby is permitted. (See CDF for its condition) Broadcast a <Standby> message.	The DUT switches to standby.
11.1.3 - 3	Ensure that the DUT handles a directly addressed <Standby> message coming from various logical addresses including the unregistered address. This test only applies if the DUT supports directly addressed <Standby> messages as Follower.	The following procedure should be repeated with the TE simulating a device at logical addresses 1, 3, 4, 5, 13, 14 and 15. Ensure that the DUT is in a state where going into standby is permitted. (See CDF for its condition) Send a <Standby> message to the DUT.	The DUT switches to standby.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.3.

CECT 11.1.4 One Touch Record

[CEC: 13.4]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.4 - 1	Ensure that the DUT sends a <Record On> [“Digital Service”] [“Digital Service Identification”] message when the user activates One Touch Record while displaying an internal tuner, for all valid recording device logical addresses. This test only applies if the DUT has an internal tuner and supports <Record On> [“Digital Service”] as Initiator (see CDF)...	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Broadcast a <Report Physical Address> message from a recording device. Ensure that the DUT is displaying an internal digital tuner. Activate the DUT’s One Touch Record feature.	The DUT sends a <Record On> [“Digital Service”] [Digital Service Identification] message with the appropriate [Digital Service Identification] parameters.
11.1.4 - 2	Ensure that the DUT sends a <Record On> ["Analogue Service"] message when the user activates One Touch Record while displaying an internal analogue tuner, for all valid recording device’s logical addresses. This test only applies if the DUT supports <Record On> [“Analogue Service”] message as Initiator.(See CDF)	The following procedure shall be repeated with the TE simulating a device at logical address 1, 2 and 9. Broadcast a <Report Physical Address> [“1.0.0.0”] from recording devices, Ensure that the DUT is displaying an internal analogue tuner. Activate the DUT's one touch record feature	The DUT sends a <Record On> [“Analogue Service”] [Analogue Broadcast Type] [Analogue Frequency] [Broadcast System] message with the appropriate Analogue Frequency and Broadcast System parameters...

Test ID	**Test Objective**	**Required Test Method**	**Pass Criteria**
11.1.4 - 3	Ensure that the DUT sends a <Record On> ["External Plug"] [External Plug] message when the user activates One Touch Record while displaying an external plug, for all valid recording device logical addresses. This test only applies if the DUT supports <Record On> [External Plug] message as Initiator.(See CDF)	The following procedure shall be repeated with the TE simulating a device at logical address 1, 2 and 9. Broadcast a <Report Physical Address> [1.0.0.0] from recording devices, Ensure that the DUT is displaying an External Plug. Activate the DUT's one touch record feature.	The DUT sends a <Record On> [“External plug”] [External Plug] message with the appropriate [External Plug] parameters.
11.1.4 - 4	Ensure that the DUT sends a <Record On> ["External Physical Address"] [External Physical Address] message when the user activates One Touch Record while displaying an external plug, for all valid recording device logical addresses. This test only applies if the DUT supports <Record On> [“External Physical Address”] message as Initiator.(See CDF)	The following procedure shall be repeated with the TE simulating a device at logical address 1, 2 and 9. Broadcast a <Report Physical Address> [1.0.0.0] from recording devices, Ensure that the DUT is displaying an External Plug. Activate the DUT's one touch record feature	The DUT sends a <Record On> [“External Physical Address”] [External Physical] message
11.1.4 - 5	Ensure that the DUT sends a <Record On> [“Own Source”] message when the user activates One Touch Record while displaying the recording devices source for all valid recording device logical addresses. Test only applies if the DUT supports <Record On> [“Own Source”] as Initiator (see CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Activate the DUT’s One Touch Record feature. (See CDF for instruction)	The DUT sends a <Record On> [“Own Source”] message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.4 - 6	Ensure that the DUT does not send a <Record On> message when the user activates One Touch Record while displaying another external source. Test only applies if the DUT supports <Record On> [“Own Source”] as Initiator and doesn’t support <Record On> [“External Plug” or <Record On> [“External Physical Address”] as Initiator. (See CDF).	Set the TE to simulate a device at logical address 1, so the DUT discovers a connected recording device. Select another external source. (ex: Analog Input 1) (See CDF for instruction). Activate the DUT’s One Touch Record feature (from the TE logical address) (See CDF for instruction).	The DUT does not send a <Record On> message.
11.1.4 - 7	Ensure that that the DUT handles a <Record Status> message correctly and sends a <Record Off> message when the user stops the recording. Test only applies if the DUT supports <Record Off> as Initiator (see CDF).	Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Activate the DUT’s One Touch Record feature (See CDF for instruction). Send the DUT a <Record Status> [“Recordingcurrently selected source”] message. Stop the recording via the DUT’s UI / Remote Control.	The DUT sends a <Record Off> message after selecting to stop the recording.
11.1.4 - 8	Ensure that the DUT handles a <Record TV Screen> message coming from a valid recording device address when displaying an internal digital tuner. This test only applies if the DUT supports <Record TV Screen> as Follower and supports <Record On> [“Digital Service”] as Initiator. (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Broadcast a <Report Physical Address> message from at logical address of the Recording Device. Ensure that the DUT is displaying an internal digital tuner. Send the DUT a <Record TV Screen> message.	The DUT sends a <Record On> [“Digital Service”] [Digital Service Identification] message with the appropriate [Digital Service Identification] parameters.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.4 - 9	Ensure that the DUT handles a <Record TV Screen> message coming from a valid recording device address when displaying the recording devices source. This test only applies if the DUT supports <Record TV Screen> as Follower and supports <Record On> ["Own Source"] as Initiator. (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Broadcast a <Report Physical Address> message from at logical address of the Recording Device. Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Send the DUT a <Record TV Screen> message.	The DUT sends a <Record On> ["Own Source"] message.
11.1.4 - 10	Ensure that the DUT handles a <Record TV Screen> message coming from a valid recording device address when displaying an internal analogue tuner. This test only applies if the DUT supports <Record TV Screen> as Follower and supports <Record On> ["Analogue Service"] as Initiator. (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Broadcast a <Report Physical Address> message from at logical address of the Recording Device. Ensure that the DUT is displaying an internal analogue tuner. Send the DUT a <Record TV Screen> message.	The DUT sends a <Record On> ["Analogue Service"] ["Analogue Broadcast Type"] ["Analogue Frequency"] ["Broadcast System"] message with the appropriate ["Analogue Broadcast Type"], ["Analogue Frequency"] and [Broadcast System] parameters.
11.1.4 - 11	Ensure that the DUT handles a <Record TV Screen> message coming from a valid recording device address when displaying an external source. This test only applies if the DUT supports <Record TV Screen> as Follower and supports <Record On> ["External Plug"] or <Record On> ["External Physical Address"] as Initiator. (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Send an <Image View On> message to the DUT from logical address 4. Broadcast an <Active Source> message from logical address 4. Send the DUT a <Record TV Screen> message.	The DUT sends a <Record On> ["External Plug"] or a <Record On> ["External Physical Address"] message with the appropriate parameters.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.4 - 12	Ensure that the DUT ignores a <Record TV Screen> message coming from a non-recording device address including the unregistered address. This test only applies if the DUT supports <Record TV Screen> as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 3, 4, 5, 14 and 15. Broadcast a <Report Physical Address> message from at logical address of the Recording Device. Send an <Image View On> message to the DUT from logical address 1. Broadcast an <Active Source> message from logical address 1. Send the DUT a <Record TV Screen> message (from the TE logical address).	The DUT ignores the <Record TV Screen> message.
11.1.4 - 13	Ensure that the DUT handles a <Record TV Screen> message coming from a valid recording device address when displaying some other source that cannot be recorded. This test only applies if the DUT supports <Record TV Screen> as Follower and does not support <Record On> [“External Physical Address”] or <Record On> [“External Plug”] as Initiator. (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Broadcast a <Report Physical Address> message from at logical address of the Recording Device. Send an <Image View On> message to the DUT from logical address 4. Broadcast an <Active Source> message from logical address 4. Send the DUT a <Record TV Screen> message (from the TE logical address).	The DUT sends a <Feature Abort> [“Cannot Provide Source”] message to the recording device.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.4.

CECT 11.1.5 Timer Programming

[CEC: 13.5]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.5 - 1	If the DUT can set timer blocks via an EPG, ensure that it sends a correctly formatted <Set Digital Timer> messages for all valid recording device addresses. This test only applies if the DUT supports <Set Digital Timer> messages as Initiator and can set a timer blocks via an EPG.	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and9,. Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Digital Timer> message with all parameters corresponding to the program that was selected.
11.1.5 - 2	If the DUT can set timer blocks via an EPG, ensure that it sends a correctly formatted <Set Analogue Timer> messages for all valid recording device addresses. This test only applies if the DUT supports <Set Analogue Timer> messages as Initiator and can set a timer blocks via an EPG.	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9, Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Analogue Timer> message with all parameters corresponding to the program that was selected.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.5 - 3	If the DUT can set timer blocks via its menu, ensure that it sends a correctly formatted <Set Digital Timer> message for all valid recording device addresses. This test only applies if the DUT supports <Set Digital Timer> messages as Initiator and can set a timer blocks via its menu.	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9,. Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the timer has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Digital Timer> message with all parameters corresponding to the timer that was set.
11.1.5 - 4	If the DUT can set timer blocks via its menu, ensure that it sends a correctly formatted <Set Analogue Timer> message for all valid recording device addresses. This test only applies if the DUT supports <Set Analogue Timer> messages as Initiator and can set a timer blocks via its menu.	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the timer has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Analogue Timer> message with all parameters corresponding to the timer that was set.
11.1.5 - 5	If the DUT can set timer blocks via its menu, ensure that it sends a correctly formatted <Set External Timer> message for all valid recording device addresses. This test only applies if the DUT supports <Set External Timer> messages as Initiator and can set a timer blocks via its menu.	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9, Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the timer has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set External Timer> message with all parameters corresponding to the timer that was set.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.5 - 6	Ensure that the DUT handles a <Timer Status> message indicating that the recording device was not programmed successfully after sending a <Set Digital Timer> message. This test only applies if the DUT supports <Set Digital Timer> messages as Initiator and can set or clear an individual timer blocks via its menu or via an EPG.	Invoke the DUT to send a <Set Digital Timer> message. Reply to the DUT with a <Timer Status> message indicating that the device was not programmed.	If the DUT provides a local list of record blocks for the device, it does not add the record block to it. The DUT may indicate on screen that the recording device was not programmed. (This is desirable – it is NOT a Requirement)
11.1.5 - 7	Ensure that the DUT handles a <Timer Status> message indicating that the recording device was not programmed successfully after sending a <Set Analogue Timer> message. This test only applies if the DUT supports <Set Analogue Timer> messages as Initiator and can set or clear an individual timer blocks via its menu or via an EPG.	Invoke the DUT to send a <Set Analogue Timer> message. Reply to the DUT with a <Timer Status> message indicating that the device was not programmed.	If the DUT provides a local list of record blocks for the device, it does not add the record block to it. The DUT may indicate on screen that the recording device was not programmed. (This is desirable – it is NOT a Requirement)
11.1.5 - 8	Ensure that the DUT handles a <Timer Status> message indicating that the recording device was not programmed successfully after sending a <Set External Timer> message. This test only applies if the DUT supports <Set Analogue Timer> messages as Initiator and can set or clear an individual timer blocks via its menu or via an EPG.	Invoke the DUT to send a <Set External Timer> message. Reply to the DUT with a <Timer Status> message indicating that the device was not programmed.	If the DUT provides a local list of record blocks for the device, it does not add the record block to it. The DUT may indicate on screen that the recording device was not programmed. (This is desirable – it is NOT a Requirement)

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.5 - 9	If the DUT can set and clear timer blocks via an EPG, ensure that it sends a correctly formatted <Clear Digital Timer> message and clears the timer from its display when receiving a <Timer Cleared Status> message. This test only applies if the DUT supports <Set Digital Timer> messages as Initiator and can clear a timer blocks via an EPG.	Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the EPG. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Digital Timer> message with all parameters corresponding to the program that was cleared. The DUT removes the timer program from its display.
11.1.5 - 10	If the DUT can set and clear timer blocks via an EPG, ensure that it sends a correctly formatted <Clear Analogue Timer> message and clears the timer from its display when receiving a <Timer Cleared Status> message. This test only applies if the DUT supports <Set Analogue Timer> messages as Initiator and can clear a timer blocks via an EPG.	Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the EPG. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Analogue Timer> message with all parameters corresponding to the program that was cleared. The DUT removes the timer program from its display.
11.1.5 - 11	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Digital Timer> messages and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating the timer was successfully cleared. This test only applies if the DUT supports <Set Digital Timer> messages as Initiator and can clear a timer blocks via its menu.	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Digital Timer> message with all parameters corresponding to the timer that was cleared. The DUT removes the timer program from its menu.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.5 - 12	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Analogue Timer> messages and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating the timer was successfully cleared. This test only applies if the DUT supports <Set Analogue Timer> messages as Initiator and can clear a timer blocks via its menu.	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Analogue Timer> message with all parameters corresponding to the timer that was cleared. The DUT removes the timer program from its menu.
11.1.5 - 13	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear External Timer> messages and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating the timer was successfully cleared. This test only applies if the DUT supports <Set External Timer> messages as Initiator and can clear a timer blocks via its menu.	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear External Timer> message with all parameters corresponding to the timer that was cleared. The DUT removes the timer program from its menu.
11.1.5 - 14	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Digital Timer> message and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating that the timer could not be cleared because there is no matching timer in the recording device This test only applies if the DUT supports <Set Digital Timer> messages as Initiator and can clear a timer blocks via its menu...	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer could not be cleared from the device as there is no matching entry.	The DUT sends a correctly formatted <Clear Digital Timer> message with all parameters corresponding to the timer that was not cleared. The DUT removes the timer program from its menu.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.5 - 15	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Analogue Timer> message and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating that the timer could not be cleared because there is no matching timer in the recording device This test only applies if the DUT supports <Set Analogue Timer> messages as Initiator and can clear a timer blocks via its menu.	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer could not be cleared from the device as there is no matching entry.	The DUT sends a correctly formatted <Clear Analogue Timer> message with all parameters corresponding to the timer that was not cleared. The DUT removes the timer program from its menu
11.1.5 - 16	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear External Timer> message and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating that the timer could not be cleared because there is no matching timer in the recording device This test only applies if the DUT supports <Set External Timer> messages as Initiator and can clear a timer blocks via its menu.	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer could not be cleared from the device as there is no matching entry.	The DUT sends a correctly formatted <Clear External Timer> message with all parameters corresponding to the timer that was not cleared. The DUT removes the timer program from its menu

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.5.

CECT 11.1.6 System Information

[CEC: 13.6]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.6 - 1	Ensure that the DUT acknowledges a polling message.	Send the DUT a <Polling Message>.	The DUT acknowledges the polling message.
11.1.6 - 2	Ensure that the DUT responds correctly to a <Give Physical Address> message coming from various logical addresses including the unregistered address.	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 3, 4, 5, 13, 14 and 15. Send the DUT a <Give Physical Address> message.	The DUT should respond by broadcasting a <Report Physical Address> message indicating the correct physical address of the device.
11.1.6 - 3	Ensure that the DUT ignores an incoming <Report Physical Address> message coming from the unregistered address.	Set the TE to simulate a device at logical address 15. Broadcast a <Report Physical Address> ["1.0.0.0"] message.	The DUT ignores the message,
11.1.6 - 4	Ensure that the DUT sends the correct messages when modifying its menu language setting. This test only applies If the DUT has a modifiable language setting (See CDF).	Modify the menu language setting on the DUT (See CDF for instruction).	The DUT broadcasts a <Set Menu Language> message.
11.1.6 - 5	Ensure that the DUT responds correctly to a <Get Menu Language> message coming from various logical addresses including the unregistered address.	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 3, 4, 5, 13, 14 and 15. After the DUT has finished sending its messages, send it a <Get Menu Language> message.	The DUT broadcasts a <Set Menu Language> message if it supports a configurable menu language.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.6 - 6	Ensure that the DUT responds correctly to a <Get CEC Version> message. This test only applies if the DUT supports <Get CEC Version> messages as Follower.(See CDF)	Send a <Get CEC Version> message to the DUT.	The DUT send a correctly formatted <CEC Version> with its CEC Version.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.6.

CECT 11.1.7 Deck Control

[CEC: 13.7]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.7 - 1	Ensure that the DUT sends the correct <Deck Control> and <Play> messages when controlling a deck. This test only applies if the DUT supports <Deck Control> and <Play> as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1 and 4. Invoke the DUT to send every possible <Deck Control> and <Play> message that its menu allows. (See CDF for its condition) Send the DUT an appropriate <Deck Status> message after each request, to indicate that the request succeeded.	The DUT sends the appropriate <Deck Control> or <Play> message for the option that was selected. If the DUT is monitoring deck status it should update its display to indicate that the request was successful (This is desirable but is NOT a requirement).

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.7 - 2	Ensure that the DUT handles a <Deck Status> message indicating that a request was successful. This test only applies if the DUT supports <Deck Control> and <Play> ["Play Forward"] as Initiator and <Deck Status> as Follower (See CDF).	Invoke the DUT to send a <Play> ["Play Forward"] message. (See CDF for instruction) Send the DUT a <Deck Status> ["Play"] message.	The DUT accepts the <Deck Status> message. If the DUT is monitoring deck status it should indicate that the deck is playing. (This is desirable but is NOT a requirement).
11.1.7 - 3	Ensure that the DUT handles a <Deck Status> message indicating that a request was not successful. This test only applies if the DUT supports <Deck Control> and <Play> ["Play Forward"] as Initiator and <Deck Status> as Follower (See CDF).	Invoke the DUT to send a <Play> ["Play Forward"] message. (See CDF for instruction) Send the DUT a <Deck Status> message indicating that the deck is stopped.	The DUT accepts the <Deck Status> message. If the DUT is monitoring deck status it should indicate that the deck is not playing. (This is desirable but is NOT a requirement).

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.7.

CECT 11.1.8 Tuner Control

[CEC: 13.8]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.8 - 1	Ensure that the DUT can send a <Tuner Step Increment> message when controlling a recording device or STB tuner. This test only applies if the DUT supports <Tuner Step Increment> as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1 and 3. Invoke the tuner control feature on the DUT (See CDF for instruction). If the DUT sends a <Give Tuner Device Status> message, respond with a <Tuner Device Status> [“Not Being used for recording”] [“Displaying Digital Tuner”] [“Service Identified Digital IDs”] ["ARIB-T "] [0x7D70 0xA000 0x7D70] (or more suitable Digital Service Identification) message. Increment the channel that is being shown on the external device via the DUT.	The DUT sends a <Tuner Step Increment> message.
11.1.8 - 2	Ensure that the DUT can send a <Tuner Step Decrement> message when controlling a recording device or STB tuner. This test only applies if the DUT supports <Tuner Step Decrement> as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1 and 3. Invoke the tuner control feature on the DUT (See CDF for instruction). If the DUT sends a <Give Tuner Device Status> message, respond with a <Tuner Device Status> [“Not Being used for recording”] [“Displaying Digital Tuner”] [“Service Identified Digital IDs”] ["ARIB-T "] [0x7D70 0xA000 0x7D70] (or more suitable Digital Service Identification) message. Decrement the channel that is being shown on the external device via the DUT.	The DUT sends a <Tuner Step Decrement> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.8 - 3	Ensure that the DUT accepts a valid <Tuner Device Status> message. This test only applies if the DUT supports <Tuner Device Status> as Follower (See CDF).	Send a <Tuner Device Status> [“Not Being used for recording”] [“Not Displaying Tuner”] [“Service Identified Digital IDs”] ["ARIB-T "] [0x7D70 0xA000 0x7D70](or more suitable Digital Service Identification) message to the DUT.	The DUT should not respond with a <Feature Abort> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.8.

CECT 11.1.9 Vendor Specific Commands

[CEC: 13.9]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.9 - 1	Ensure that the DUT accepts a <Give Device Vendor ID> message from various logical addresses including the unregistered logical address (15). This test only applies if the DUT supports <Give Device Vendor ID> as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 3, 4, 5, 13, 14 and 15. Send a <Give Device Vendor ID> message to the DUT.	The DUT responds by broadcasting a <Device Vendor ID> message with the correct ID depending upon the vendor.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.9 - 2	If the DUT can attempt to send a <Vendor Command> to another vendor's device, ensure the DUT does not send a Vendor Specific Commands to a device that it does not recognize. This test only applies if the DUT supports <Vendor Command> as Initiator and can try to send a <Vendor Command> to device with Vendor IDs that are different from the DUT.	The TE shall simulate a device that has a Vendor ID that is different from the DUT, and simulates a device at logical address that the DUT tries to send the Vendor Specific Commands. (See CDF for Vendor ID that is different from the DUT's, and logical address to send the Vendor Specific Commands.) Broadcast a <Report Physical Address> message from the TE Broadcast a <Device Vendor ID> message from the TE. Invoke the DUT to send a <Vendor Command> message. (See CDF for instruction to initiate the Vendor Specific function.)	The DUT does not send any <Vendor Command> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.9.

CECT 11.1.10 OSD Display

[CEC: 13.10]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.10 - 1	Check that the DUT accepts a <Set OSD String> message and is capable of displaying the message for a default time from various logical addresses. This test only applies if the DUT supports <Set OSD String> as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 3, 4, 5, 13 and 14. Ensure the DUT is in a state where displaying OSD Strings is allowed. (See CDF for its condition) Send the DUT a <Set OSD String> ["Display For Default Time"] ['Test String'].	The DUT displays the message for a default time period and then clears the message. (The time period is locally specified - a typical value is 5 seconds).
11.1.10 - 2	Check that the DUT accepts a <Set OSD String> message and is capable of displaying the message until it receives a clear message. This test only applies if the DUT supports <Set OSD String> as Follower (See CDF).	Ensure the DUT is in a state where displaying OSD Strings is allowed. (See CDF for its condition) Send the DUT a <Set OSD String> ["Display Until Cleared"] ['Test String']. Wait for a period in excess of the devices default display time. (It is recommended to wait for 20s or more). Send a <Set OSD String> ["Clear Previous Message"].	The DUT displays the message 'Test String' on receipt of the first message. The DUT clears the OSD text on receipt of the second message. Note: It is possible that the DUT may overwrite the message with an internally generated message, which could be blank. This is acceptable behavior.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.10 - 3	Check that the DUT accepts a <Set OSD String> message and is capable of overwriting an OSD string with a new OSD string from another initiator. This test only applies if the DUT supports <Set OSD String> as Follower (See CDF).	Ensure the DUT is in a state where displaying OSD Strings is allowed. (See CDF for its condition) Set the TE to simulate a device at logical address 1. Send the DUT a <Set OSD String> [“Display Until Cleared”] [‘Test String’] message. Set the TE to simulate a device at logical address 2. Send a <Set OSD String> [“Display For Default Time”] [‘Second String’].	The DUT displays the message ‘Test String’ on receipt of the first message. The DUT removes the previous message and displays the message ‘Second String’ on receipt of the second message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.10

CECT 11.1.11 Device OSD Name Transfer

[CEC: 13.11]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.11 - 1	Ensure that the DUT sends a <Give OSD Name> message whenever it discovers a new device at any logical address and ensure that it accepts a <Set OSD Name> message in response. This test only applies if the DUT supports <Give OSD Name> as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 3, 4, 5, 13 and 14. Broadcast a <Report Physical Address> [1.0.0.0] message. After the DUT sends a <Give OSD Name> message, send a <Set OSD Name> ['Test Device'] to the DUT.	The DUT shall send a <Give OSD Name> message to the appropriate address. The DUT shall accept the <Set OSD Name> message and refer to the device as 'Test Device' in any menu or OSD associated with that device.
11.1.11 - 2	Ensure that the DUT does not send a <Give OSD Name> message when it discovers a new device at the unregistered logical address. This test only applies if the DUT supports <Give OSD Name> as Initiator (See CDF).	Set the TE to simulate a device at logical address 15. Broadcast a <Report Physical Address> [1.0.0.0] message.	The DUT does NOT send a <Give OSD Name> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.11.

CECT 11.1.12 Device Menu Control

[CEC: 13.12]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.12 - 1	Ensure that the DUT reacts correctly to a <Menu Status> ["Activated"] message from the current active source at various logical addresses, when the TV is not controlling a menu. This test only applies if the DUT supports <Menu Status> as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses that can be accepted device types by the DUT on the Device Menu Activated. (See CDF) Ensure that the DUT is in a state where forwarding the remote control key press is allowed. (See CDF for its condition) Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Send a <Menu Status> ["Activated"] message to the DUT. Press a remote control key that the DUT will forward. (See CDF) Repeat the procedure for several other remote control keys that the DUT will forward.	The DUT sends a <User Control> message when the remote control key is pressed. The DUT does not handle the remote control key press locally

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.12 - 2	Ensure that the DUT ignores a <Menu Status> message coming from the unregistered logical address (15). This test only applies if the DUT supports <Menu Status> as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure that the DUT is in a state where forwarding the remote control key press is allowed. (See CDF for its condition) Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Send a <Menu Status> [“Activated”] message to the DUT. Press the ‘UP’ key on the DUT’s remote control.	The DUT ignores the <Menu Status> message. The DUT handles the remote control press locally. No <User Control> message is sent.
11.1.12 - 3	Ensure that the DUT reacts correctly to a <Menu Status> [“Deactivated”] message from the current active source when the TV is controlling a menu. This test only applies if the DUT supports <Menu Status> as Follower (See CDF).	Ensure that the DUT is in a state where forwarding the remote control key press is allowed. (See CDF for its condition) Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Send a <Menu Status> [“Activated”] message to the DUT. Send a <Menu Status> [“Deactivated”] message to the DUT from the current source device. Press the ‘UP’ key on the DUT’s remote control.	The DUT handles the remote control press locally. No <User Control> message is sent.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.12 - 4	Ensure that the DUT sends a <Menu Request> ["Activate"] message to the current active source when the Device Menu Control feature is invoked and the source device is not currently displaying a menu. This test only applies if the DUT supports <Menu Request> as Initiator (See CDF).	Ensure that the DUT is in a state where forwarding the remote control key press is allowed. (See CDF for its condition) Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Invoke the Device Menu Control Feature on the DUT.	The DUT sends a <Menu Request> ["Activate"] message to the current active source device.
11.1.12 - 5	Ensure that the DUT sends a <Menu Request> ["Deactivate"] message when the Device Menu Control Feature is deactivated and the source device is currently displaying a menu. This test only applies if the DUT supports <Menu Request> as Initiator (See CDF).	Ensure that the DUT is in a state where forwarding the remote control key press is allowed. (See CDF for its condition) Send an <Image View On> message to the DUT. Broadcast an <Active Source> message. Send a <Menu Status> ["Activated"] message to the DUT. Deactivate the Device Menu Control Feature on the DUT. (See CDF for its instruction)	The DUT sends a <Menu Request> ["Deactivate"] message to the current source device.
11.1.12 - 6	Ensure that the DUT ignores a <Menu Status> message when it is not displaying a CEC source device. This test only applies if the DUT supports <Menu Status> as Follower (See CDF).	Ensure that the DUT is displaying its internal tuner or a non-CEC external source and is in a state where forwarding the remote control key press is allowed. (See CDF for its condition) Send a <Menu Status> ["Activated"] message to the DUT. Press the 'UP' key on the DUT's remote control	The DUT ignores the message. The DUT handles the remote control press locally. No <User Control> message is sent.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.12 - 7	Ensure that the DUT correctly handles a <Menu Status> message that does not come from the current source device. This test only applies if the DUT supports <Menu Status> as Follower (See CDF).	Ensure that the DUT is in a state where forwarding the remote control key press is allowed. (See CDF for its condition) Send an <Image View On> message to the DUT from logical address 1. Broadcast an <Active Source> message from logical address 1. Send a <Menu Status> [“Activated”] message to the DUT from logical address 2. Press the ‘UP’ key on the DUT’s remote control.	The DUT ignores the <Menu Status> message. The DUT handles the remote control press locally. No <User Control> message is sent.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.12.

CECT 11.1.13 Remote Control Pass Through

[CEC: 13.13]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.13 - 1	Ensure that the DUT sends the appropriate messages for remote control pass through to a Recording Device. This test only applies if the DUT supports <User Control Pressed> as Initiator and has the "Recording Device" setting (i.e. Select the Recording Device as a target device. See condition/instruction for Initiator of <User Control Pressed> of CDF).	Set the TE to simulate a device at address 1. Ensure the DUT's remote control is set to the “Recording Device” setting. (See CDF for instruction) Press a remote control key that the DUT will forward to the recording device. (See CDF) Repeat the procedure for several other remote control keys that the DUT will forward to the recording device.	The DUT sends a <User Control Pressed> message with the correct key code for the button pressed. The DUT sends a <User Control Released> message when the button is released.
11.1.13 - 2	Ensure that the DUT sends the appropriate messages for remote control pass through to a Playback Device. This test only applies if the DUT supports <User Control Pressed> as Initiator and has the "Playback Device" setting (i.e. Select the Playback Device as a target device. See condition/instruction for Initiator of <User Control Pressed> of CDF).	Set the TE to simulate a device at address 4. Ensure the DUT's remote control is set to the “Playback Device” setting. (See CDF for instruction) Press a remote control key that the DUT will forward to the Playback Device. (See CDF) Repeat the procedure for several other remote control keys that the DUT will forward to the Playback Device.	The DUT sends a <User Control Pressed> message with the correct key code for the button pressed. The DUT sends a <User Control Released> message when the button is released.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.13 - 3	Ensure that the DUT sends the appropriate messages for remote control pass through to a Tuner. This test only applies if the DUT supports <User Control Pressed> as Initiator and has the "Tuner" setting (i.e. Select the Tuner as a target device. See condition/instruction for Initiator of <User Control Pressed> of CDF).	Set the TE to simulate a device at address 3. Ensure the TVs remote control is set to the “Tuner” setting. (See CDF for instruction) Press a remote control key that the DUT will forward to the Tuner. (See CDF) Repeat the procedure for several other remote control keys that the DUT will forward to the Tuner.	The DUT sends a <User Control Pressed> message with the correct key code for the button pressed. The DUT sends a <User Control Released> message when the button is released.
11.1.13 - 4	Ensure that the DUT sends the appropriate messages for remote control pass through to an Audio System. This test only applies if the DUT supports <User Control Pressed> as Initiator and has the "Audio System" setting (i.e. Select the Audio System as a target device. See condition/instruction for Initiator of <User Control Pressed> of CDF).	Set the TE to simulate a device at address 5. Ensure the TVs remote control is set to the “Audio System” setting. (See CDF for instruction) Press a remote control key that the DUT will forward to the Audio System. (See CDF) Repeat the procedure for several other remote control keys that the DUT will forward to the Audio System.	The DUT sends a <User Control Pressed> message with the correct key code for the button pressed. The DUT sends a <User Control Released> message when the button is released.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.13 - 5	Ensure that the DUT behaves sensibly when the remote control pass through feature is invoked in a system with multiple devices of the same type. This test only applies if the DUT supports <User Control> as Initiator (See CDF).	This procedure assumes that the DUT supports Remote Control Pass Through for Record Devices. If it doesn't, adjust the addresses as appropriate for multiple Playback Devices or Tuners. Set the TE to simulate a device at address 1. Broadcast a <Report Physical Address> [1.1.0.0] message from logical address 1. Broadcast a <Report Physical Address> [1.2.0.0] message from logical address 2. Ensure the TVs remote control is set to the "Recording Device" setting. (See CDF for instruction) Press a remote control key that the DUT will forward to the recording device. (See CDF) Repeat the procedure for several other remote control keys that the DUT will forward to the recording device.	The DUT should select a single device to forward the remote control command to. The DUT should not send multiple messages to multiple record devices.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.13.

CECT 11.1.14 Give Device Power Status

[CEC: 13.14]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.14 - 1	Ensure that the DUT responds correctly to a <Give Device Power Status> message.	Ensure the DUT is power on. Send the DUT a <Give Device Power Status> message.	The DUT responds by sending a <Report Power Status> ["On"] message.
11.1.14 - 2	Ensure that the DUT responds correctly to a <Give Device Power Status> message. This test only applies if the DUT supports < <Report Power Status> ["Standby"] as Initiator (See CDF).	Ensure the DUT is standby. Send the DUT a <Give Device Power Status> message.	The DUT responds by sending a <Report Power Status> ["Standby"] message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.14.

CECT 11.1.15 System Audio Control

[CEC: 13.15]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.15 - 1	Ensure that the DUT send correctly formatted <System Audio Mode Request> message. This test only applies if the DUT supports <System Audio Mode Request> messages as Initiator.(See CDF)	Ensure that the TE simulates devices at logical address 5 and 1. Broadcast <Report Physical Address> [1.0.0.0] message from logical address 5. Broadcast <Report Physical Address> [1.1.0.0] message from logical address 1. Broadcast <Image View On> and <Active Source> [1.1.0.0] message from logical address 1. Invoke the DUT to the System Audio Mode to become On.	The DUT send <System Audio Mode Request> [1.1.0.0] to the device at logical address 5.
11.1.15 - 2	Ensure that the DUT issues correctly a <User Control Pressed> [Volume UP/ Volume Down] when the System Audio Control is On. This test only applies if the DUT supports <Set System Audio Mode> messages as Follower.(See CDF)	Send a <Set System Audio Mode> [“On”] message to the DUT from logical address 5. Invoke the DUT to change volume control by the DUT’s local or remote control. (e.g. pressing volume up / down key on its control)	The DUT issue a <User Control Pressed> [Volume up / down]. And the DUT doesn't change its volume level.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.15 - 3	Ensure that the DUT issues correctly a <User Control Pressed> [“Mute”] when the System Audio Control is On. This test only applies if the DUT supports <Set System Audio Mode> messages as Follower.(See CDF)	Send a <Set System Audio Mode> [“On”] message to the DUT from logical address 5. Invoke the DUT to change volume control to mute or un-mute by the DUT’s local or remote control. (e.g. pressing mute / un-mute key on its control)	The DUT issues a <User Control Pressed> [“Mute”] message. And the DUT doesn't change its volume level.
11.1.15 - 4	Ensure that the DUT issues correctly a <Give System Audio Status> when it is brought out of standby. This test only applies if the DUT supports <Give System Audio Mode> messages as Initiator.(See CDF)	Ensure that the TE simulates a device at logical address 5. Broadcast a <Report Physical Address> message. Ensure the DUT is in standby. Power on the DUT.	The DUT issues a <Give System Audio Status> message to the amplifier.
11.1.15 - 5	Ensure that the DUT issues a correctly formatted <System Audio Mode Request> message when becoming the System Audio Mode to be Off. This test only applies if the DUT supports <System Audio Mode Request> messages as Initiator.(See CDF)	Broadcast a <Set System Audio Mode> [“On”] message from logical address 5 Invoke the DUT to turn off the System Audio Control.	The DUT sends a <System Audio Mode Request> with no operands to the amplifier. The DUT may un-mutes its volume.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.15.

CECT 11.1.16 Audio Rate Control

[CEC: 13.16]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.1.16 - 1	Ensure that the DUT sends directly addressed <Set Audio Rate> messages in a correct timing if the user activates this feature. This test only applies if the DUT supports <Set Audio Rate> messages as Initiator (See CDF).	Ensure that user activates this feature. Measure time span between the directly addressed <Set Audio Rate> messages.	The DUT sends directly addressed <Set Audio Rate> messages at least once every 2 seconds. The parameter [Audio Rate] shall be “0”, ”1”, ”2”, ”3”, ”4”,” 5”, or ”6”.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.1.16.

CECT 11.2 Non TV Device

Configuration

For testing non-TV devices, the Source Device to TV Configuration (see CECT 5.4) shall be used except where explicitly stated. An HDMI output of the DUT shall be connected to an HDMI input of the test equipment. The test equipment shall by default mimic a device at logical address 0 and send all messages from this address (except where otherwise stated).

CECT 11.2.1 One Touch Play

[CEC: 13.1]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.1 - 1	Ensure that the DUT sends an <Image View On> or <Text View On> message followed by an <Active Source> message when the One Touch Play feature is initiated. This test only applies if the DUT can become active source.	Initiate the One Touch Play feature on the DUT.	The DUT sends an <Image View On> or <Text View On> message as locally specified and then broadcasts an <Active Source> message.
11.2.1 - 2	Ensure that the DUT ignores an <Active Source> message from logical address 15. This test only applies if the DUT can become active source.	Set the TE to simulate a device at logical address 15. Ensure that the DUT is the current active source. Broadcast an <Active Source> message.	The DUT ignores the <Active Source> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.1.

CECT 11.2.2 Routing Control

[CEC: 13.2]

Required Test Method

Test ID	**Test Objective**	**Required Test Method**	**Pass Criteria**
11.2.2 - 1	Ensure that the DUT responds correctly to a <Set Stream Path> message that indicates it as the device to stream to. This test only applies if the DUT supports <Set Stream Path> message as Follower (See CDF).	Broadcast a <Active Source> message indicating that another device is active source. Broadcast a <Set Stream Path> message indicating that the DUT is now the active source.	The DUT broadcasts an <Active Source> message and streams its content to the display.
11.2.2 - 2	Ensure that the DUT responds correctly to a <Request Active Source> message when it is the current active source. This test only applies if the DUT supports <Request Active Source> message as Follower (See CDF).	Ensure the DUT is now the active source. Broadcast a <Request Active Source> message.	The DUT responds <Active Source> to the <Request Active Source> message.
11.2.2 - 3	Ensure that the DUT responds correctly to a <Request Active Source> message from various logical addresses including the unregistered address (15), when it is the current active source. This test only applies if the DUT supports <Request Active Source> message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (1, 3, 4, 5 and 15). Ensure the DUT is now the active source. Broadcast a <Request Active Source> message.	The DUT responds to the <Request Active Source> message by broadcasting an <Active Source> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.2 - 4	If the DUT is a current active source, the DUT shall issue <Inactive Source> when going into standby. This test only applies if the DUT supports <Inactive Source> messages as Initiator.(See CDF)	Broadcast a <Set Stream Path> message with the physical address of the DUT. Invoke the DUT to send <Inactive Source>. (i.e. When the DUT goes into standby)(See CDF).	The DUT send a directly addressed <Inactive Source> message with the physical address of the DUT to the TV.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.2.

CECT 11.2.3 System Standby

[CEC: 13.3]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.3 - 1	If the DUT can initiate the system standby feature, check that it broadcasts a correctly formatted <Standby> message. This test only applies if the DUT supports broadcasting <Standby> messages as Initiator. (See CDF)	Ensure that the DUT is in a state where going into standby is permitted. Initiate the System Standby feature on the DUT.	The DUT must broadcast a <Standby> message, before going into standby itself.

Test ID	**Test Objective**	**Required Test Method**	**Pass Criteria**
11.2.3 - 2	Check that the DUT accepts a broadcast <Standby> message from various logical addresses including the unregistered address and switches to standby. This test only applies if the DUT supports broadcasted <Standby> messages as Follower.	The following procedure shall be repeated with the TE simulating a device at various logical addresses (1, 3, 4, 5 and 15). Ensure that the DUT is in a state where going into standby is permitted. Broadcast a <Standby> message.	The DUT switches to standby.
11.2.3 - 3	Check that the DUT accepts a directly addressed <Standby> message from various logical addresses including the unregistered address and switches to Standby. This test only applies if the DUT supports directly addressed <Standby> messages as Follower.	The following procedure shall be repeated with the TE simulating a device at various logical addresses (1, 3, 4, 5 and 15). Ensure that the DUT is in a state where going into standby is permitted. Send a <Standby> message to the DUT.	The DUT switches to standby.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.3.

CECT 11.2.4 One Touch Record

[CEC: 13.4]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.4 - 1	Ensure that the DUT sends a <Record TV Screen> message to the TV, when the One Touch Record feature is invoked locally and accepts a <Feature Abort> in response. This test only applies if the DUT supports <Record TV Screen> as Initiator (See CDF).	Ensure the DUT has media loaded and is ready to record. (See CDF for instruction) Invoke the One Touch Record feature on the DUT. (See CDF for instruction) After the DUT sends a <Record TV Screen> message, send the DUT a <Feature Abort> ["Cannot Provide Source"] message.	The DUT sends a <Record TV Screen> message to the TV. The DUT accepts the <Feature Abort> and does not begin recording.
11.2.4 - 2	Ensure that the DUT accepts a <Record On> ["Digital Service"] ["Digital Service Identification"] message and records the service specified. This test only applies if the DUT supports <Record On> ["Digital Service"] as Follower (See CDF).	Ensure that the DUT selects a valid digital service ID (["Service Identified by Digital IDs"] ["ARIB-T"] [0x7D70 0xA000 0x7D70] (or more suitable Digital Service identification). (See CDF for instruction) Ensure that the DUT has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> ["Digital Service"] ["Service Identified Digital IDs"] ["ARIB-T"] [0x7D70 0xA000 0x7D70] (the same as the digital service identification that the DUT selected) message to the DUT with a specified service.	The DUT changes its tuner to the specified service and begins recording. The DUT responds with a <Record Status> ["Recording Digital Service"] message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.4 - 3	Ensure that the DUT accepts a <Record On> [“Analogue Service”] [“Analogue Broadcast Type”] [“Analogue Frequency”] [“Broadcast System”] message and records the service specified. This test only applies if the DUT supports <Record On> [“Analogue Service”] as Follower (See CDF).	Ensure that the DUT selects a valid Analogue Service (For example [“Terrestrial”] [0x00 0x00] ["NTSC M"] (or more suitable frequency)). (See CDF for instruction) Ensure that the DUT has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> [“Analogue Service”] [“(the same as the Operands that the DUT selected)”] message to the DUT with a specified service.	The DUT changes its tuner to the specified service and begins recording. The DUT responds with a <Record Status> [“Recording Analogue Service”] message.
11.2.4 - 4	Ensure that the DUT accepts a <Record On> [“External Plug”] message and records the External Plug specified. This test only applies if the DUT supports <Record On> [“External Plug”] as Follower (See CDF).	Ensure that the DUT selects a external plug.(i.e. external plug 1)(See CDF for instruction) Ensure that the DUT has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> [“External plug"] [“(the same as the external plug number that the DUT selected)”] message to the DUT with a specified plug.	The DUT changes its tuner to the specified service and begins recording. The DUT responds with a <Record Status> [“Recording External Input”] message.
11.2.4 - 5	Ensure that the DUT accepts a <Record On> [“External Physical Address”] message and records the External Physical Address specified. This test only applies if the DUT supports <Record On> [“External Physical Address”] as Follower (See CDF).	Ensure that the DUT selects an external plug. (See CDF for instruction) Ensure that the DUT has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> [“External Physical Address"] [“(the physical address of the device that is the same as the selected external plug)”] message to the DUT with a specified plug.	The DUT changes its tuner to the specified service and begins recording. The DUT responds with a <Record Status> [“Recording External Input”] message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.4 - 6	Ensure that the DUT accepts a <Record On> [“Own Source”] message when it is displaying an internal tuner. This test only applies if the DUT supports <Record On> [“Own Source”] as Follower (See CDF).	Ensure the DUT is displaying an internal tuner. (See CDF for instruction) Ensure that the DUT has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> [“Own Source”] message to the DUT.	The DUT begins recording the service it is tuned to. The DUT responds with a <Record Status> [“Recording currently selected source”] message.
11.2.4 - 7	Ensure that the DUT accepts a <Record On> [“Own Source”] message when it is displaying an external source (if applicable). This test only applies if the DUT supports <Record On> [“Own Source”] as Follower (See CDF).	Ensure the DUT is displaying some external source (e.g. a camcorder). (See CDF for instruction) Ensure that the DUT has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> [“Own Source”] message to the DUT.	The DUT begins recording the external source. The DUT responds with a <Record Status> [“Recordingcurrently selected source”] message.
11.2.4 - 8	Ensure that the DUT accepts a <Record Off> message when it is recording and it comes from the Initiator of the <Record On> message. This test only applies if the DUT supports <Record On> [“Own Source”] as Follower (See CDF).	Ensure the DUT is displaying an internal tuner, has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> [“Own Source”] message to the DUT. Send a <Record Off> message to the DUT.	The DUT stops recording on receipt of the <Record Off> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.4 - 9	Ensure that the DUT accepts a <Record On> and corresponding <Record Off> message from various logical addresses. This test only applies if the DUT supports <Record On> as Follower.(See CDF)	The following procedure shall be repeated with the TE simulating a device at various logical addresses (1, 3, 4 and 5). Send a <Record On> message that can be received to the DUT. (e.g. send a <Record On> ["Own Source"] message if the DUT supports ["Own Source"].See CDF.) Send a <Record Off> message to the DUT.	The DUT begins recording the tuner it is tuned to. The DUT responds with a <Record Status> message with correctly formatted operands. The DUT stops recording on receipt of the <Record Off> message.
11.2.4 - 10	Ensure that the DUT ignores a <Record On> message from the unregistered logical address (15). This test only applies if the DUT supports <Record On> as Follower. (See CDF)	Set the TE to simulate a device at logical address 15. Ensure the DUT is displaying an internal tuner, has media loaded and is ready to record. (See CDF for instruction) Send a <Record On> message that can be received to the DUT. (e.g. send a <Record On> ["Own Source"] message if the DUT supports ["Own Source"]. See CDF.)	The DUT ignores the incoming <Record On> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.4.

CECT 11.2.5 Timer Programming

[CEC: 13.5]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 1	If the DUT can set timer blocks via an EPG, ensure that it sends a correctly formatted <Set Digital Timer> messages for all valid recording device addresses. This test only applies if the DUT (i.e. Tuner) supports < Set Digital Timer> message as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2, and 9. Broadcast a <Report Physical Address> from logical address of a recording device. Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Digital Timer> message with all parameters corresponding to the program that was selected.
11.2.5 - 2	If the DUT can set timer blocks via an EPG, ensure that it sends a correctly formatted <Set Analogue Timer> messages for all valid recording device addresses. This test only applies if the DUT (i.e. Tuner) supports < Set Analogue Timer> message as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2, and 9. Broadcast a <Report Physical Address> from logical address of a recording device. Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Analogue Timer> message with all parameters corresponding to the program that was selected.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 3	If the DUT can set timer blocks via its menu, ensure that it sends a correctly formatted <Set Digital Timer> message for all valid recording device addresses. This test only applies if the DUT (I.e. Tuner) supports < Set Digital Timer> message as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2, and 9. Broadcast a <Report Physical Address> from logical address of a recording device. Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the timer has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Digital Timer> message with all parameters corresponding to the timer that was set.
11.2.5 - 4	If the DUT can set timer blocks via its menu, ensure that it sends a correctly formatted <Set Analogue Timer> message for all valid recording device addresses. This test only applies if the DUT (I.e. Tuner) supports <Set Analogue Timer> message as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Broadcast a <Report Physical Address> from logical address of a recording device. Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the timer has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set Analogue Timer> message with all parameters corresponding to the timer that was set.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 5	If the DUT can set timer blocks via its menu, ensure that it sends a correctly formatted <Set External Timer> message for all valid recording device addresses. This test only applies if the DUT (I.e. Tuner) supports <Set External Timer> message as Initiator (See CDF).	The following procedure shall be repeated with the TE simulating a device at logical addresses 1, 2 and 9. Broadcast a <Report Physical Address> from logical address of a recording device. Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the timer has been programmed and that enough media is available.	The DUT sends a correctly formatted <Set External Timer> message with all parameters corresponding to the timer that was set.
11.2.5 - 6	Ensure that the DUT handles a <Timer Status> message indicating that the recording device was not programmed successfully after sending a <Set Digital Timer> message. This test only applies if the DUT supports < Set Digital Timer> message as Initiator (See CDF).	Invoke the DUT to send a <Set Digital Timer> message. (i.e. set a timer recording via its menu or via its EPG.) Reply to the DUT with a <Timer Status> message indicating that the device was not programmed.	If the DUT provides a local list of record blocks for the device, it does not add the record block to it. The DUT may indicate on screen that the recording device was not programmed. (This is desirable – it is NOT a Requirement)
11.2.5 - 7	Ensure that the DUT handles a <Timer Status> message indicating that the recording device was not programmed successfully after sending a <Set Analogue Timer> message. This test only applies if the DUT supports < Set Analogue Timer> message as Initiator (See CDF).	Invoke the DUT to send a <Set Analogue Timer> message. (i.e. set a timer recording via its menu or via its EPG.) Reply to the DUT with a <Timer Status> message indicating that the device was not programmed.	If the DUT provides a local list of record blocks for the device, it does not add the record block to it. The DUT may indicate on screen that the recording device was not programmed. (This is desirable – it is NOT a Requirement)

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 8	Ensure that the DUT handles a <Timer Status> message indicating that the recording device was not programmed successfully after sending a <Set External Timer> message. This test only applies if the DUT supports < Set External Timer> message as Initiator (See CDF).	Invoke the DUT to send a <Set External Timer> message. (i.e. set a timer recording via its menu or via its EPG.) Reply to the DUT with a <Timer Status> message indicating that the device was not programmed.	If the DUT provides a local list of record blocks for the device, it does not add the record block to it. The DUT may indicate on screen that the recording device was not programmed. (This is desirable – it is NOT a Requirement)
11.2.5 - 9	If the DUT can set and clear timer blocks via an EPG, ensure that it sends a correctly formatted <Clear Digital Timer> message and clears the timer from its display when receiving a <Timer Cleared Status> message. This test only applies if the DUT (I.e. Tuner) supports < Set Digital Timer> message as Initiator (See CDF).	Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the EPG. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Digital Timer> message with all parameters corresponding to the program that was cleared. The DUT removes the timer program from its display.
11.2.5 - 10	If the DUT can set and clear timer blocks via an EPG, ensure that it sends a correctly formatted <Clear Analogue Timer> message and clears the timer from its display when receiving a <Timer Cleared Status> message. This test only applies if the DUT (I.e. Tuner) supports < Set Analogue Timer> message as Initiator (See CDF).	Set a timer recording via the EPG. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the EPG. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Analogue Timer> message with all parameters corresponding to the program that was cleared. The DUT removes the timer program from its display.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 11	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Digital Timer> messages and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating the timer was successfully cleared. This test only applies if the DUT (I.e. Tuner) supports < Set Digital Timer> message as Initiator (See CDF).	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Digital Timer> message with all parameters corresponding to the timer that was cleared. The DUT removes the timer program from its menu.
11.2.5 - 12	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Analogue Timer> messages and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating the timer was successfully cleared. This test only applies if the DUT (I.e. Tuner) supports < Set Analogue Timer> message as Initiator (See CDF).	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear Analogue Timer> message with all parameters corresponding to the timer that was cleared. The DUT removes the timer program from its menu.
11.2.5 - 13	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear External Timer> messages and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating the timer was successfully cleared. This test only applies if the DUT (I.e. Tuner) supports < Set External Timer> message as Initiator (See CDF).	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer has been successfully cleared.	The DUT sends a correctly formatted <Clear External Timer> message with all parameters corresponding to the timer that was cleared. The DUT removes the timer program from its menu.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 14	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Digital Timer> message and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating that the timer could not be cleared because there is no matching timer in the recording device. This test only applies if the DUT (I.e. Tuner) supports < Set Digital Timer> message as Initiator (See CDF).	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer could not be cleared from the device as there is no matching entry.	The DUT sends a correctly formatted <Clear Digital Timer> message with all parameters corresponding to the timer that was not cleared. The DUT removes the timer program from its menu.
11.2.5 - 15	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear Analogue Timer> message and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating that the timer could not be cleared because there is no matching timer in the recording device. This test only applies if the DUT (I.e. Tuner) supports < Set Analogue Timer> message as Initiator (See CDF).	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer could not be cleared from the device as there is no matching entry.	The DUT sends a correctly formatted <Clear Analogue Timer> message with all parameters corresponding to the timer that was not cleared. The DUT removes the timer program from its menu

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 16	If the DUT can set and clear timer blocks via its menu, ensure that it sends a correctly formatted <Clear External Timer> message and clears the timer from its menu when receiving a <Timer Cleared Status> message indicating that the timer could not be cleared because there is no matching timer in the recording device. This test only applies if the DUT (I.e. Tuner) supports < Set External Timer> message as Initiator (See CDF).	Set a timer recording via the menu. Send the DUT a <Timer Status> message indicating that the recording has been programmed and that enough media is available. Clear that timer recording via the menu. Send the DUT a <Timer Cleared Status> message indicating that the timer could not be cleared from the device as there is no matching entry.	The DUT sends a correctly formatted <Clear External Timer> message with all parameters corresponding to the timer that was not cleared. The DUT removes the timer program from its menu
11.2.5 - 17	Ensure that the DUT handles correctly a <Set Analogue Timer> messages and responds with <Timer Status>. This test only applies if the DUT(i.e. Recording Device) supports <Set Analogue Timer> messages as Follower.(See CDF)	Ensure that the DUT has media loaded and is ready to record. Send a <Set Analogue Timer> message to the DUT.	The DUT sets timer blocks internally to record analogue service, and responds a <Timer Status> message.
11.2.5 - 18	Ensure that the DUT handles correctly a <Set Digital Timer> messages and responds with <Timer Status>. This test only applies if the DUT(i.e. Recording Device) supports <Set Digital Timer> messages as Follower.(See CDF)	Ensure that the DUT has media loaded and is ready to record. Send a <Set Digital Timer> message to the DUT.	The DUT sets timer blocks internally to record digital service, and responds a <Timer Status> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.5 - 19	Ensure that the DUT handles correctly a <Set External Timer> messages and responds with <Timer Status>. This test only applies if the DUT(i.e. Recording Device) supports <Set External Timer> messages as Follower.(See CDF)	Ensure that the DUT has media loaded and is ready to record. Send a <Set External Timer> message to the DUT.	The DUT sends timer blocks internally to record external input, and responds a <Timer Status> message.
11.2.5 - 20	Ensure that the DUT handles correctly a <Clear Analogue Timer> messages and responds with <Timer Cleared Status>. This test only applies if the DUT(i.e. Recording Device) supports <Clear Analogue Timer> messages as Follower.(See CDF)	Ensure that the DUT has media loaded and is ready to record. Send a <Set Analogue Timer> message to the DUT. Send a <Clear Analogue Timer> message with operands that same as previously sending <Set Analogue Timer> to the DUT.	The DUT sends a <Timer Status> message when receiving <Set Analogue Timer> message. The DUT responds <Timer Cleared Status> message to a <Clear Analogue Timer> message.
11.2.5 - 21	Ensure that the DUT handles correctly a <Clear Digital Timer> messages and responds with <Timer Cleared Status>. This test only applies if the DUT(i.e. Recording Device) supports <Clear Digital Timer> messages as Follower.(See CDF)	Ensure that the DUT has media loaded and is ready to record. Send a <Set Digital Timer> message to the DUT. Send a <Clear Digital Timer> message with operands that same as previously sending <Set Digital Timer> to the DUT.	The DUT sends a <Timer Status> message when receiving <Set Digital Timer> message. The DUT responds <Timer Cleared Status> message to a <Clear Digital Timer> message.
11.2.5 - 22	Ensure that the DUT handles correctly a <Clear External Timer> messages and responds with <Timer Cleared Status>. This test only applies if the DUT(i.e. Recording Device) supports <Clear External Timer> messages as Follower.(See CDF)	Ensure that the DUT has media loaded and is ready to record. Send a <Set External Timer> message to the DUT. Send a <Clear External Timer> message with operands that same as previously sending <Set External Timer> to the DUT.	The DUT sends a <Timer Status> message when receiving <Set External Timer> message. The DUT responds <Timer Cleared Status> message to a <Clear External Timer> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.5.

CECT 11.2.6 System Information

[CEC: 13.6]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.6 - 1	Ensure that the DUT correctly acknowledges a polling message.	Send the DUT a <Polling message>.	The DUT ACKs the message.
11.2.6 - 2	Ensure that the DUT responds correctly to a <Give Physical Address> message from various logical addresses including the unregistered address. This test only applies if the DUT supports <Give Physical Address> as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4, 5 and 15) except the DUT's LA. Send the DUT a <Give Physical Address> message.	The DUT responds by broadcasting a <Report Physical Address> message indicating the correct physical address of the device.
11.2.6 - 3	Ensure that the DUT handles a <Set Menu Language> message correctly. This test only applies If the DUT has a modifiable language setting (See CDF)	Broadcast a <Set Menu Language> message with a different language to the currently set value and supported menu language.	The DUT update the menu language settings that it locally store.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.6 - 4	Ensure that the DUT handles a <Set Menu Language> message with unsupported language correctly. This test only applies If the DUT has a modifiable language setting (See CDF)	Broadcast a <Set Menu Language> message with a different language to the currently set value and not supported configurable languages.	The DUT menu language setting is not modified.
11.2.6 - 5	Ensure that the DUT ignores a <Set Menu Language> message coming from a logical address other than 0 (TV). This test only applies If the DUT has a modifiable language setting (See CDF)	The following procedure shall be repeated with the TE simulating a device at various logical addresses (1, 3, 4, 5 and 15). Broadcast a <Set Menu Language> message (from the test equipment address) with a different language to the currently set value on the DUT.	The DUT menu language setting is not modified.
11.2.6 - 6	Ensure that the DUT handles a <Get CEC Version> message . This test only applies if the DUT supports <Get CEC Version> messages as Follower.(See CDF)	Send a <Get CEC Version> message to the DUT.	The DUT send a correctly formatted <CEC Version> with its CEC Version.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.6.

CECT 11.2.7 Deck Control

[CEC: 13.7]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.7 - 1	Ensure that the DUT responds to a <Deck Control> ["Skip Forward/Wind"] message. This test only applies if the DUT supports <Deck Control> ["Skip Forward/Wind"] message as Follower (See CDF).	Ensure that the DUT is playing media. Send the message <Deck Control> ["Skip Forward/Wind"] to the DUT.	The DUT responds to the message and skips/winds forward depending upon the device type.
11.2.7 - 2	Ensure that the DUT responds to a <Deck Control> ["Skip Reverse/Rewind"] message. This test only applies if the DUT supports <Deck Control> ["Skip Reverse/Rewind"] message as Follower (See CDF).	Ensure that the DUT is playing media. Send the message <Deck Control> ["Skip Reverse/Rewind"] to the DUT.	The DUT responds to the message and skips backwards/rewinds depending upon the device type.
11.2.7 - 3	Ensure that the DUT responds to a <Deck Control> ["Stop"] message when it is playing. This test only applies if the DUT supports <Deck Control> ["Stop"] message as Follower (See CDF).	Ensure that the DUT is playing media. Send the message <Deck Control> ["Stop"] to the DUT.	The DUT stops playing.
11.2.7 - 4	Ensure that the DUT accepts a valid <Deck Control> message from various logical addresses. This test only applies if the DUT supports <Deck Control> ["Stop"] message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's LA. Ensure that the DUT is playing media. Send the message <Deck Control> ["Stop"] to the DUT.	The DUT stops playing.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.7 - 5	Ensure that the DUT ignores a <Deck Control> message from the unregistered logical address (15). This test only applies if the DUT supports <Deck Control> ["Stop"] as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure that the DUT is playing media. Send the message <Deck Control> ["Stop"] to the DUT.	The DUT ignores the message.
11.2.7 - 6	Ensure that the DUT responds to a <Play> ["Play Forward"] message when it is stopped but has media loaded. This test only applies if the DUT supports <Play> ["Play Forward"] message as Follower (See CDF).	Ensure the DUT has media available and is idle. Send the message <Play> ["Play Forward"] to the DUT.	The DUT begins playing its media.
11.2.7 - 7	Ensure that the DUT responds to a <Play> ["Play Reverse"] message when it is stopped but has media loaded. This test only applies if the DUT supports <Play> ["Play Reverse"] message as Follower (See CDF).	Ensure the DUT has media available and is idle. Send the message <Play> ["Play Reverse"] to the DUT.	If capable, the DUT starts playing in reverse.
11.2.7 - 8	Ensure that the DUT responds to a <Play> ["Play Still"] message when it is playing. This test only applies if the DUT supports <Play> ["Play Still"] message as Follower (See CDF).	Ensure that the DUT is playing media. Send the message <Play> ["Play Still"] to the DUT.	The DUT switches from playing forwards to still mode (paused).

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.7 - 9	Ensure that the DUT responds to a <Play> ["Play Still"] message when it is stopped but has media loaded. This test only applies if the DUT supports <Play> ["Play Still"] message as Follower (See CDF).	Ensure the DUT has media available and is idle. Send the message <Play> ["Play Still"] to the DUT.	The DUT enters still mode. (Displays a frozen picture). OR (depending on local specification) The DUT sends a <Feature Abort> and remains idle.
11.2.7 - 10	Ensure that the DUT responds to a <Play> message with all valid ["Slow Forward *speed*"], ["Slow Reverse *speed*"], ["Fast Forward *speed*"] and ["Fast Reverse *speed*"] operands when it is stopped but has media loaded. This test only applies if the DUT supports <Play> message with operands above as Follower (See CDF).	Ensure the DUT has media available and is idle. Send the message <Play> ["Fast Forward Min Speed"] addressed from TV to the DUT. Repeat the above process for the following parameters: (It is needed to test for only the operands supported <Play> as Follower by the DUT.) ["Fast Forward Medium Speed"] ["Fast Forward Max Speed"] ["Fast Reverse Min Speed"] ["Fast Reverse Medium Speed"] ["Fast Reverse Max Speed"] ["Slow Forward Min Speed"] ["Slow Forward Medium Speed"] ["Slow Forward Max Speed"] ["Slow Reverse Min Speed"] ["Slow Reverse Medium Speed"] ["Slow Reverse Max Speed"]	The DUT sends an <Image View On> or <Text View On> message to the TV. The DUT starts playing in scan mode at the selected speed (or a sensible close match if that speed is not supported). OR (depending on local specification) The DUT sends a <Feature Abort> and remains idle.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.7 - 11	Ensure that the DUT responds to a <Play> message with all valid [“Slow Forward *speed*”], [“Slow Reverse *speed*”], [“Fast Forward *speed*”] and [“Fast Reverse *speed*”] operands when it is playing. This test only applies if the DUT supports <Play> message as Follower with operands above (See CDF).	Ensure that the DUT is playing media. Send the message <Play> [“Fast ForwardMin Speed”] addressed from TV to the DUT. Repeat the above process for the following parameters: (It is needed to test for only the operands supported <Play> as Follower by the DUT.) [“Fast Forward Medium Speed”] [“Fast Forward Max Speed”] [“Fast Reverse Min Speed”] [“Fast Reverse Medium Speed”] [“Fast Reverse Max Speed”] [“Slow Forward Min Speed”] [“Slow Forward Medium Speed”] [“Slow Forward Max Speed”] [“Slow Reverse Min Speed”] [“Slow Reverse Medium Speed”] [“Slow ReverseMax Speed”]	The DUT switches to playing in the selected mode and speed (or a sensible close match if that speed is not supported).
11.2.7 - 12	Ensure that the DUT responds to a <Play> message from various logical addresses. This test only applies if the DUT supports <Play> [“Play Forward”] message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (1, 3, 4 and 5) except the DUT's LA. Ensure the DUT has media available and is idle. Send the message <Play> [“Play Forward”] to the DUT.	The DUT begins playing its media.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.7 - 13	Ensure that the DUT ignores a <Play> message from the unregistered logical address (15). This test only applies if the DUT supports <Play> ["Play Forward"] message as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure the DUT has media available and is idle. Send the message <Play> ["Play Forward"] to the DUT.	The DUT ignores the message.
11.2.7 - 14	Ensure that the DUT generates a correctly formatted <Deck Status> messages in response to a <Give Deck Status> ["Once"] message. This test only applies if the DUT supports <Give Deck Status> ["Once"] message as Follower and supports <Deck Status> messages as Initiator with operands above (See CDF).	Ensure the DUT is playing forwards. Send a <Give Deck Status> ["Once"] message to the DUT. Repeat the test for each of the followingstates: (It is needed to test for only the state supported <Deck Status> as initiator by the DUT.) Playing Reverse Paused Still Slow Forwards Slow Reverse Fast Forward Fast Reverse Stopped (Idle) media present No media present Skip Forward or Winding(if applicable) Skip Reverse or Rewinding(if applicable) Recording (if applicable) Index Search Forward (if applicable) Index Search Reverse (if applicable)	The DUT responds with the appropriate <Deck Status> message for the decks state. The parameter returned shall be as follows: Playing Forwards – ["Play"] Playing Reverse – ["Play Reverse"] Paused – ["Still"] Slow Forwards – ["Slow"] Slow Reverse – ["Slow Reverse"] Fast Forwards – ["Search Forward"] Fast Reverse – ["Search Reverse"] Stopped (Idle) media present – ["Stop"] No media present – ["No Media"] Skip Forward or Winding – ["Skip Forward/Wind"] iSkip Reverse or Rewinding– ["Skip Reverse/Rewind"] Recording – ["Record"] Index Search Forward- ["Index Search Forward"] Index Search Reverse - ["Index Search Reverse"]

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.7 - 15	Ensure that the DUT responds correctly to the <Give Deck Status> message with the parameters [“On”] and [“Off”]. This test only applies if the DUT supports <Give Deck Status> [“On”] and [“Off”] message as Follower (See CDF).	Ensure the DUT is idle and contains media. Send a <Give Deck Status> [“On”] message to the DUT. Press play on the DUT to start playing the media. Press stop on the DUT to stop the media playing. Send a <Give Deck Status> [“Off”] message to the DUT. Press play on the DUT to start playing the media.	The DUT responds on receipt of the <Give Deck Status> message with a <Deck Status> [“Stop”] message. The DUT sends a <Deck Status> [“Play”] message when it starts playing. The DUT sends a <Deck Status> [“Stop”] message when it is stopped. The DUT does not send any other <Deck Status> message.
11.2.7 - 16	Ensure that the DUT handles a <Give Deck Status> message from various logical addresses. This test only applies if the DUT supports <Give Deck Status> [“Once”] message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (1, 3, 4 and 5) except the DUT's LA. Ensure that the DUT is playing media. Send a <Give Deck Status> [“Once”] message to the DUT.	The DUT responds with a <Deck Status> [“Play”] message.
11.2.7 - 17	Ensure that the DUT ignores a <Give Deck Status> message from the unregistered logical address (15). This test only applies if the DUT supports <Give Deck Status> [“Once”] message as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure that the DUT is playing media. Send a <Give Deck Status> [“Once”] message to the DUT.	The DUT ignores the message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.7 - 18	Ensure that the DUT responds to a <Deck Control> [“Eject”] message. This test only applies if the DUT supports <Deck Control> [“Eject”] messages as Follower (See CDF).	Ensure that the DUT is media loaded. Send the message <Deck Control> [“Eject”] to the DUT.	The DUT ejects its media.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.7.

CECT 11.2.8 Tuner Control

[CEC: 13.8]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.8 - 1	Ensure that the DUT handles a <Select Digital Service> message correctly from various logical addresses for a service that the device has set and is not currently tuned to. This test only applies if the DUT supports <Select Digital Service> as Follower.	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's LA. Ensure the DUT is powered on, selects service 1. (e.g. Digital Service Identification is ["Service Identified by Digital IDs"] ["ARIB-T"] [0x7D70 0xA000 0x7D70]) Send the DUT a <Select Digital Service> message for service 2. (e.g. Digital Service Identification is ["Service Identified Digital IDs"] ["ARIB-T"] [0x7FD1 0x0808 0x7FD1])	The DUT's tuner changes to service 2.
11.2.8 - 2	Ensure that the DUT ignores a <Select Digital Service> message coming from the unregistered logical address (15). This test only applies if the DUT supports <Select Digital Service> as Follower.	Set the TE to simulate a device at logical address 15. Ensure the DUT is powered on, selects service 1. (e.g. Digital Service Identification is ["Service Identified Digital IDs"] ["ARIB-T"] [0xA000 0x7D70 0x7D70]) Send the DUT a <Select Digital Service>message for service 2. (e.g. Digital Service Identification is ["Service Identified Digital IDs"] ["ARIB-T"] [0x7FD1 0x0808 0x7FD1])	The DUT ignores the message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.8 - 3	Ensure that the DUT handles a <Select Digital Service> message correctly for a service that the device has set and is already tuned to. This test only applies if the DUT supports <Select Digital Service> as Follower.	Ensure the DUT is powered on, selects service 1. (e.g. Digital Service Identification is ["Service Identified Digital IDs"] ["ARIB-T"] [0xA000 0x7D70 0x7D70]) Send the DUT a <Select Digital Service> for service 1 message. (e.g. Digital Service Identification is ["Service Identified Digital IDs"] ["ARIB-T "] [0xA000 0x7D70 0x7D70])	The DUT shall ignore the message and the tuner remains on the same service.
11.2.8 - 4	Ensure that the DUT handles a <Select Analogue Service> message correctly from various logical addresses for a service that the device has set and is not currently tuned to. This test only applies if the DUT supports <Select Analogue Service> as Follower.	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's L.A. Ensure the DUT is powered on, selects service 1. (e.g. ["Terrestrial"] [0x00 0x00] ["NTSC_M"]) Send the DUT a <Select Analogue Service> message for service 2. (e.g. ["Terrestrial"] [0x00 0xFF] ["NTSC M"] or more suitable one that is different from service 1.)	The DUT's tuner changes to service 2.
11.2.8 - 5	Ensure that the DUT ignores a <Select Analogue Service> message coming from the unregistered logical address (15). This test only applies if the DUT supports <Select Analogue Service> as Follower.	Set the TE to simulate a device at logical address 15. Ensure the DUT is powered on, selects service 1. (e.g. ["Terrestrial"] [0x00 0x00] ["NTSC M"] or more suitable one.) Send the DUT a <Select Analogue Service>message for service 2. (e.g. ["Terrestrial"] [0x00 0x00] ["NTSC M"] or more suitable one.)	The DUT ignores the message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.8 - 6	Ensure that the DUT handles a <Select Analogue Service> message correctly for a service that the device has set and is already tuned to. This test only applies if the DUT supports <Select Analogue Service> as Follower.	Ensure the DUT is powered on, selects service 1. (e.g. [“Terrestrial”] [0x00 0x00] [“NTSC M”] or more suitable one.) Send the DUT a <Select Analogue Service> for service 1 message. (e.g.[“Terrestrial”] [0x00 0x00] [“NTSC M”] or more suitable one.)	The DUT shall ignore the message and the tuner remains tuned on the same service.
11.2.8 - 7	Ensure that the DUT handles a <Tuner Step Increment> message correctly from various logical addresses. This test only applies if the DUT supports <Tuner Step Increment> message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's LA. Ensure the DUT is powered on. Send a <Tuner Step Increment> message to the DUT.	The DUT goes to a higher preset number, or wraps around to the beginning of the preset list.
11.2.8 - 8	Ensure that the DUT ignores a <Tuner Step Increment> message coming from the unregistered logical address (15). This test only applies if the DUT supports <Tuner Step Increment> message as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure the DUT is powered on. Send a <Tuner Step Increment> message to the DUT.	The DUT ignores the message.
11.2.8 - 9	Ensure that the DUT handles a <Tuner Step Decrement> message correctly from various logical addresses. This test only applies if the DUT supports <Tuner Step Decrement> message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's logical address. Ensure the DUT is powered on Send a <Tuner Step Decrement> message to the DUT.	The DUT goes to a lower preset number, or wraps around to the end of the preset list.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.8 - 10	Ensure that the DUT ignores a < Tuner Step Decrement > message coming from the unregistered logical address (15). This test only applies if the DUT supports <Tuner Step Decrement> message as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure the DUT is powered on. Send a <Tuner Step Decrement> message to the DUT.	The DUT ignores the message.
11.2.8 - 11	Ensure that the DUT handles a <Give Tuner Device Status> [“Once”] message from various logical addresses, when it is displaying its tuner. This test only applies if the DUT supports < Give Tuner Device Status > [“Once”] message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's logical address. Ensure the DUT is displaying its tuner. Send the DUT a <Give Tuner Device Status> [“Once”] message.	The DUT responds with a <Tuner Device Status> message indicating that it is displaying its tuner and the correctservice identification.
11.2.8 - 12	Ensure that the DUT ignores a <Give Tuner Device Status> [“Once”] message from the unregistered logical address (15). This test only applies if the DUT supports < Give Tuner Device Status > [“Once”]message as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure the DUT is displaying its tuner. Send the DUT a <Give Tuner Device Status> [“Once”] message.	The DUT ignores the <Tuner Device Status> message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.8 - 13	Ensure that the DUT handles the <Give Tuner Device Status> [“On”] and <Give Tuner Device Status> [“Off”] messages correctly. This test only applies if the DUT supports < Give Tuner Device Status > [“On”] and [“Off”] message as Follower (See CDF).	Ensure the DUT is displaying its tuner. Send the DUT a <Give Tuner Device Status> [“On”] message. Change the service that the DUT is tuned to. (See CDF for instruction) Send the DUT a <Give Tuner Device Status> [“Off”]. Change the service that the DUT is tuned to.	The DUT responds with a <Tuner Device Status> message indicating that it is displaying its tuner and the correct service. The DUT sends an additional <Tuner Device Status> message indicating the new service. The DUT does not send a third <Tuner Device Status> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.8.

CECT 11.2.9 Vendor Specific Commands

[CEC: 13.9]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.9 - 1	Ensure that the DUT accepts a <Give Device Vendor ID> message from various logical addresses including the unregistered logical address (15). This test only applies if the DUT supports < Give Device Vendor ID > as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4, 5 and 15) except the DUT's LA. Send a <Give Device Vendor ID> message to the DUT.	The DUT responds by broadcasting a <Device Vendor ID> message with the correct ID depending upon the vendor.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.9 - 2	Ensure that the DUT broadcasts a <Device Vendor ID> messages after a successful initialization and address allocation. This test only applies if the DUT supports <Device Vendor ID> as Initiator. (See CDF)	Disconnect the DUT to the TE.(or HPD is asserted from the TE). Set the TE to allocate a physical address of 1.0.0.0 to the DUT. Connect the DUT to the TE.	The DUT broadcasts a <Device Vendor ID> message with the correct ID depending upon the vendor.
11.2.9 - 3	If the DUT can attempt to send a <Vendor Command> to another vendor's device, ensure the DUT does not send a Vendor Specific Commands to a device that it does not recognize. This test only applies if the DUT supports <Vendor Command> as Initator and can try to send a <Vendor Command> to the device whose Vendor IDs that are different from the DUT.	The TE shall simulate a device that has a Vendor ID that is different from the DUT, and simulates a device at logical address that the DUT tries to send the Vendor Specific Commands.(See CDF for Vendor ID that is different from the DUT, and logical address to send the Vendor Specific Commands.) Broadcast a <Report Physical Address> message from the TE Broadcast a <Device Vendor ID> message from the TE. Invoke the DUT to send a <Vendor Command> message. (See CDF for instruction to initiate the Vendor Specific function.)	The DUT does not send any <Vendor Command> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.9.

CECT 11.2.10 OSD Display

[CEC: 13.10]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.10 - 1	Check that the DUT sends out a correctly formatted <Set OSD String> [Display Control] [OSD String] message. (If possible) This test only applies if the DUT supports <Set OSD String> message as Initiator (See CDF).	If possible, set the DUT into a mode that utilizes the TV's OSD feature and invoke an OSD message by altering the parameter currently displayed on the OSD.	The DUT sends a <Set OSD String> message with the correct [OSD String] parameter.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.10.

CECT 11.2.11 Device OSD Name Transfer

[CEC: 13.11]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.11 - 1	Ensure that the DUT responds correctly to a <Give OSD Name> message coming from various logical addresses. This test only applies if the DUT supports <Give OSD Name> message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's LA. Send the DUT a <Give OSD Name> message.	The DUT responds with a <Set OSD Name> message to the appropriate logical address.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.11 - 2	Ensure that the DUT ignores a <Give OSD Name> message from the unregistered logical address (15). This test only applies if the DUT supports <Give OSD Name> message as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Send the DUT a <Give OSD Name> message.	The DUT ignores the message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.11

CECT 11.2.12 Device Menu Control

[CEC: 13.12]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.12 - 1	Ensure that the DUT sends a <Menu Status> ["Activated"] message when its menu is activated locally. This test only applies if the DUT supports <Menu Status> message as Initiator and the DUT has a means to activate its menu (See CDF).	Ensure the DUT's menu is not activated. (See CDF for instruction) Ensure the DUT is now the active source. Locally activate the device menu. (See CDF for instruction)	The DUT sends a <Menu Status> ["Activated"] message when activating the menu.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.12 - 2	Ensure that the DUT sends a <Menu Status> [“Deactivated”] message when its menu is deactivated locally. This test only applies if the DUT supports <Menu Status> message as Initiator and the DUT has a means to deactivate its menu (See CDF).	Ensure the DUT's menu is activated. (See CDF for instruction) Ensure the DUT is now the active source. (See CDF for instruction) Locally deactivate the device menu. (See CDF for instruction)	The DUT sends a <Menu Status> [“Deactivated”] message when deactivating the menu.
11.2.12 - 3	Ensure that the DUT responds correctly to a <Menu Request> [“Activate”] message. This test only applies if the DUT supports <Menu Request> message as Follower (See CDF).	Ensure the DUT is now the active source. Send a <Menu Request> [“Activate”] message to the DUT.	The DUT sends a <Menu Status> [“Activated”] or <Menu Status> ["Deactivated"] message in response.
11.2.12 - 4	Ensure that the DUT responds correctly to a <Menu Request> [“Deactivate”] message. This test only applies if the DUT supports <Menu Request> message as Follower (See CDF).	Ensure the DUT is now the active source. Send a <Menu Request> [“Deactivate”] message to the DUT.	The DUT sends a <Menu Status> [“Deactivated”] or <Menu Status> ["Activated"] message in response.
11.2.12 - 5	Ensure that the DUT responds to a <Menu Request> message from various logical addresses. This test only applies if the DUT supports <Menu Request> message as Follower (See CDF).	The following procedure shall be repeated with the TE simulating a device at various logical addresses (0, 1, 3, 4 and 5) except the DUT's LA. Ensure the DUT is now the active source. Send a <Menu Request> [“Query”] message to the DUT (from the TE address).	The DUT responds by sending a <Menu Status> [“Activated”] or <Menu Status> ["Deactivated"] message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.12 - 6	Ensure that the DUT ignores a <Menu Request> message from the unregistered logical address (15). This test only applies if the DUT supports <Menu Request> message as Follower (See CDF).	Set the TE to simulate a device at logical address 15. Ensure the DUT is now the active source. Send a <Menu Request> [“Query”] message to the device (from the TE address).	The DUT ignores the message.
11.2.12 - 7	Ensure that the DUT responds correctly to a <User Control Pressed> and corresponding <User Control Released> message when displaying a menu. This test only applies if the DUT supports <User Control Pressed> and <User Control Released> messages as Follower (See CDF).	Ensure the DUT is now the active source. Send a <Menu Request> [“Activate”] message to the DUT. Send a <User Control Pressed> message for all valid user control codes that the DUT supports among following ones. Select, Up, Down, Left, Right For each user control sent, send a <User Control Released> message directly after.	The DUT’s menu is activated. The DUT’s menu reacts sensibly to the incoming messages.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.12.

CECT 11.2.13 Remote Control Pass Through

[CEC: 13.13]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.13 - 1	Ensure that the DUT responds correctly to a <User Control Pressed> message followed immediately by a <User Control Released> message. This test only applies if the DUT supports <User Control Pressed> and <User Control Released> messages as Follower (See CDF).	Send the DUT a <User Control Pressed> message for a remote control key that the DUT should handle. Send the DUT a <User Control Released> message. Repeat the above procedure for several other valid remote control codes.	The DUT handles the message as if the remote control key was pressed locally.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.13.

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CECT 11.2.14 Give Device Power Status

[CEC: 13.14]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.14 - 1	Ensure that the DUT responds correctly to a < Give Device Power Status> message.	Ensure the DUT is power on. Send the DUT a <Give Device Power Status> message.	The DUT responds by sending a <Report Power Status> ["On"] message.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.14 - 2	Ensure that the DUT responds correctly to a < Give Device Power Status> message. This test only applies if the DUT supports <Report Power Status> [“Standby”] as Initiator. (See CDF).	Ensure the DUT is standby. Send the DUT a <Give Device Power Status> message.	The DUT responds by sending a <Report Power Status> [“Standby”] message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.14.

CECT 11.2.15 System Audio Control

[CEC: 13.15]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.15 - 1	Ensure that the DUT handles <System Audio Mode Request> messages with its child physical address coming from various logical address. This test only applies if the DUT(i.e. amplifier) supports <System Audio Mode Request> messages as Follower.(See CDF)	The following procedure shall be repeated with TE simulating a device at logical address 0, 3. Send a <System Audio Mode Request> [0.0.0.0] to the DUT.	The DUT broadcasts <Set System Audio Mode> [“On”].

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.15 - 2	Ensure that the DUT issues <Set System Audio Mode> correctly when the feature is initiated from the DUT. This test only applies if the DUT(i.e. amplifier) supports <Set System Audio Mode> messages as Initiator, and can initiate the System Audio Mode Function via its control (See CDF)	Ensure that the TE simulates the device at logical address 0, Invoke the DUT to initiate the System Audio mode to On. The TE responds <Active Source> [0.0.0.0] to a <Request Active Source> message.	The DUT send <Set System Audio Mode> [“On”] to logical address 0. The DUT broadcasts a <Set System Audio Mode> [“On”]
11.2.15 - 3	Ensure that the DUT doesn’t issue <Set System Audio Mode> correctly when the feature is initiated from the DUT, but the TV responds with <Feature Abort> to <Set System Audio Mode> This test only applies if the DUT(i.e. amplifier) supports <Set System Audio Mode> messages as Initiator, and can initiate the System Audio Mode Function via its control (See CDF)	Ensure that the TE simulates the device at logical address 0, Invoke the DUT to initiate the System Audio mode to On. The TE responds <Active Source> [0.0.0.0] to a <Request Active Source> message. The TE shall responds with <Feature Abort> message to the directly addressed <Set System Audio Mode> message.	The DUT send <Set System Audio Mode> [“On”] to logical address 0. The DUT shall not broadcast a <Set System Audio Mode> [“On”]
11.2.15 - 4	Ensure that the DUT responds correctly to a <Give System Audio Status> when the System Audio Mode is On. This test only applies if the DUT(i.e. amplifier) supports <Set System Audio Mode> messages as Initiator and supports <Give System Audio Status> messages as Follower.(See CDF)	Send a <System Audio Mode Request> [“0.0.0.0”] to the DUT. Send a <Give System Audio Status> message to the DUT.	The DUT broadcasts a <Set System Audio Mode> [“On”] message. The DUT responds <System Audio Mode Status> [“On”] to a <Give System Audio Status> message

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.15 - 5	Ensure that the DUT send a <Set System Audio Mode> ["Off]" message when receiving a <System Audio Mode Request> message with no operands. This test only applies if the DUT(i.e. amplifier) supports <Set System Audio Mode> messages as Initiator.(See CDF)	Ensure that the TE simulates the device at logical address 0, Send a <System Audio Mode Request> [0.0.0.0] to the DUT. Send a <System Audio Mode Request> message with no operands.	The DUT broadcasts a <Set System Audio Mode> ["Off"] message.
11.2.15 - 6	Ensure that the DUT send a <Set System Audio Mode> ["Off"] message before goes into standby when the System Audio Mode is On. This test only applies if the DUT(i.e. amplifier) supports <Set System Audio Mode> messages as Initiator.(See CDF)	Ensure that the TE simulates the device at logical address 0, Send a <System Audio Mode Request> [0.0.0.0] to the DUT. Invoke the DUT to go into standby.	The DUT sends <Set System Audio Mode> ["Off"] before go into standby.
11.2.15 - 7	Ensure that the DUT responds correctly to a <Give System Audio Status> message when the System Audio Mode is Off. This test only applies if the DUT(i.e. amplifier) supports <Set System Audio Mode> messages as Initiator and supports <Give System Audio Status> messages as Follower.(See CDF)	Ensure that the System Audio Mode is Off. Send a <Give System Audio Status> message to the DUT	The DUT responds <System Audio Mode Status> ["Off"].
11.2.15 - 8	Ensure that the DUT handles correctly a <User Control Pressed> ["Mute"] message when the System Audio Mode is On. This test only applies if the DUT(i.e. amplifier) supports <Set System Audio Mode> messages as Initiator.(See CDF)	Ensure that the TE simulates the device at logical address 0, Send a <System Audio Mode Request> [0.0.0.0] to the DUT. Send <User Control Pressed> ["Mute"] and <User Control Released>.	The DUT accepts <User Control Pressed> and <User Control Released>, and mutes its volume.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.15 - 9	Ensure that the DUT responds correctly to a <Give Audio Status>. This test only applies if the DUT(i.e. amplifier) supports <Give Audio Status> as Follower.(See CDF)	Send a <System Audio Mode Request> [0.0.0.0] to the DUT. Send a <Give Audio Status> to the DUT	The DUT responds with <Report Audio Status> [“Audio Status”]
11.2.15 - 10	Ensure that the DUT send a <Give System Audio Status> when it goes standby to On. This test only applies if the DUT(i.e. Tuner) supports <Give Audio Mode Status> messages as Initiator. (See CDF)	Ensure that the TE simulate the device at logical address 5. Broadcast a <Report Physical Address> message. The DUT shall be standby. Invoke the DUT to turn on.	The DUT sends <Give System Audio Mode Status> to a device at logical address 5.
11.2.15 - 11	Ensure that the DUT issues correctly a <User Control Pressed> [Volume UP/ Volume Down] when the System Audio Control is On. This test only applies if the DUT(i.e. Tuner) supports <Set System Audio Mode> messages as Follower and supports <User Control Pressed> messages as Initiator.(See CDF)	Send a <Set System Audio Mode> [“On”] message to the DUT from logical address 5. Press the volume up/down key on the DUT's local or remote control.	The DUT issue a <User Control Pressed> [Volume up / down]. And the DUT doesn't change its volume level.
11.2.15 - 12	Ensure that the DUT issues correctly a <User Control Pressed> [“Mute”] when the System Audio Control is On. This test only applies if the DUT(i.e. Tuner) supports <Set System Audio Mode> messages as Follower and supports <User Control Pressed> messages as Initiator.(See CDF)	Send a <Set System Audio Mode> [“On”] message to the DUT from logical address 5. Press the volume mute or un-mute key on the DUT's local or remote control.	The DUT issues a <User Control Pressed> [“Mute”] message. And the DUT doesn't change its volume level.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.15.

CECT 11.2.16 Audio Rate Control

[CEC: 13.16]

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
11.2.16 - 1	Ensure that the DUT accept a directly addressed <Set Audio Rate> message. This test only applies if the DUT supports <Set Audio Rate> messages as Follower (See CDF).	Ensure that the DUT playing an audio media such as CD, Super Audio CD or DVD-AUDIO. Send the DUT 4 directly addressed <Set Audio Rate> [Audio Rate] messages in 2 seconds or less span according to the two sequences below. Sequence 1 : [Audio Rate] = “1” -> “2” -> “3” -> “0” Sequence 2 : [Audio Rate] = “4” -> “5” -> “6” -> “0”	The DUT ACKs all the <Set Audio Rate> messages in either Sequence 1 or Sequence 2.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.2.16.

CECT 11.3 CEC Switch

The following are the set of tests that must be carried out on a CEC Switch. The tests listed as mandatory must be run. In addition there is a section detailing additional tests for CEC Switches that may be manually switched.

Reference	Requirement
[CEC: 11] Switch Requirements [CEC: 13.1] One Touch Play [CEC: 13.2] Routing Control	The DUT can act correctly for each Feature and Manual Switching

Configuration

For non-TV devices including CEC Switch functionality and pure CEC Switches, an HDMI output of the DUT shall be connected to an HDMI input of the test equipment. It is not necessary to test TV devices including CEC Switch functionality. (It is tested on CECT11.1.2.)

CECT 11.3.1 Mandatory Tests

[CEC: 11.1]

Required Test Method

Test ID	**Test Objective**	**Required Test Method**	**Pass Criteria**
11.3.1 - 1	Ensure that the DUT reacts correctly to an <Active Source> message when it does not need to change its switch position.	Ensure the DUT is switched to its child at position 1. Broadcast an <Active Source> message, indicating a physical address below the DUT's child position 1.	The DUT does not switch.

Test ID	Test Objective	Required Test Method	Pass Criteria
11.3.1 - 2	Ensure that the DUT reacts correctly to an <Active Source> message when it does need to change its switch position.	Ensure the DUT is switched to its child at position 1. Broadcast an <Active Source> message indicating a physical address below the DUT's child position 2.	The DUT switches to position 2.
11.3.1 - 3	Ensure that the DUT reacts correctly to a <Set Stream Path> message when it does not need to change its switch position.	Ensure the DUT is switched to its child at position 1. Broadcast a <Set Stream Path> message indicating a physical address below the DUT's child position 1.	The DUT does not switch.
11.3.1 - 4	Ensure that the DUT reacts correctly to a <Set Stream Path> message when it does need to change its switch position.	Ensure the DUT is switched to its child at position 1. Broadcast a <Set Stream Path> message, indicating a physical address below the DUT's child position 2.	The DUT switches to position 2.
11.3.1 - 5	Ensure that the DUT reacts correctly to a <Routing Change> message.	Allocate the DUT a physical address of 1.0.0.0. Ensure the DUT is switched to its child at position 1 (the device at 1.1.0.0). Broadcast a <Routing Change> [0.0.0.0] [1.0.0.0] message (Emulating that TV device switched from its internal source to HDMI input.).	The DUT broadcasts a <Routing Information> [1.1.0.0] message.
11.3.1 - 6	Ensure that a CEC Switch reacts correctly to a <Routing Information> message.	Ensure the DUT is switched to its child at position 1. Broadcast a <Routing Information> [1.0.0.0] message to the DUT.	The DUT broadcasts a <Routing Information> [1.1.0.0] message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.3.1.

CECT 11.3.2 Optional Tests If Manual Switching Is Possible.

The following test shall be carried out for CEC Switches where manual switching is allowed. [CEC: 11.1]

Test ID	Test Objective	Required Test Method	Pass Criteria
11.3.2 - 1	Ensure that the DUT broadcasts a <Routing Change> message when it is manually switched.	Allocate the DUT a physical address of 1.0.0.0. Ensure the DUT is currently switched to child 1 (the device at 1.1.0.0). Switch the DUT manually to child 2 (the device at 1.2.0.0).	The DUT broadcasts a <Routing Change> [1.1.0.0] [1.2.0.0] message

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 11.3.2.

CECT 12 Invalid Message Tests

The Invalid message tests shall be run for every message that a device supports. [CEC: 12] [CEC: 17]

Reference	Requirement
[CEC: 12] High Level Protocol	The DUT correctly supports Mandatory or declared Features and Messages.

Configuration

This set of tests shall use the Basic Configuration (see CECT Figure 1).

Required Test Method

Test ID	Test Objective	Required Test Method	Pass Criteria
12 - 1	For every message that the DUT can receive that is defined as broadcast only, ensure that it ignores it when it is received as a directly addressed message.	For every message that the DUT can receive and should only be accepted when broadcast, send it as a directly addressed message to the DUT.	The DUT ignores the message.
12 - 2	For every message that the DUT can receive that is defined as directly addressed only, ensure that the DUT ignores it when it is received as a broadcast message.	For every message that the DUT can receive and should only be accepted when directly addressed, send it as a broadcast message.	The DUT ignores the message.
12 - 3	Ensure that the DUT ignores every broadcast message that the DUT does not support.	For every message that the DUT does not support and should only be accepted when broadcast, send it to the DUT.	The DUT ignores the message.

Test ID	Test Objective	Required Test Method	Pass Criteria
12 - 4	Ensure that the DUT responds <Feature Abort> to a directly addressed message that the DUT does not support. This test applies to a device except for pure CEC Switch.	Send an <Abort> message to the DUT.	The DUT responds a <Feature Abort> message.

Recommended Test Method

Check the pass criteria of each test by following the directions provided by the CEC Compliance Test Tool for CECT 12.

Appendix 1 CEC Capabilities Declaration Form

The following declaration must be completed prior to CEC testing. The information that is entered will be used to determine which groups of tests are performed. If DUT has plural device types, following declaration form must be completed for each device type, because supported messages may be different between each device type.

CEC Capability	*Choices*		*Value*	*Comments*	
CEC Device Type(s)	TV/Display (Y/N)				
	Recording Device (Y/N)				
	Tuner (Y/N)				
	Playback Device (Y/N)				
	Audio System (Y/N)				
	CEC Switch (Y/N)				
Does the device act as a Root device (Meaning: DUT is a Sink or Repeater and DUT's Physical Address is 0.0.0.0 and DUT's EDID(s) [if present] contain Source Physical Address of P.0.0.0)	Y / N				
Number of HDMI Inputs	(from General sheet)		0		
Are the CEC signals on input connectors independent? (Meaning: no physical connection between inputs and DUT has a logical address of 0 for all inputs). [Note: If device has no HDMI inputs, answer "N".]	Y / N				
Number of HDMI Outputs	(from General sheet)		0		
Port # of the CEC-capable output	0 - X				
How many independent CEC lines are in the product, driven by independent CEC driving circuitry and logical processing? *- If there is only one CEC line, or all connectors share the same CEC line driver and logical processor, answer 1;* *- If there are multiple independent CEC systems, indicate the number of independent CEC systems*	1 - X				
Does CEC enabling initial setting exist?	Y / N				(*1)

*1: If Y, setting instruction is needed. (ex: see page ** of attached instruction Manual, etc.)

CEC Features / Messages Supported

The following form must be filled in to declare the set of CEC features and messages that the DUT supports.

*1: If Y, setting instruction is needed. (ex: see page ** of attached instruction Manual, etc.)

CEC Feature	*Choices*	*Value*				*Comments*
CEC Message		*Support as Initiator?*		*Support as Follower?*		*Comments*
		Choices	*Value*	*Choices*	*Value*	
	Choices	*Value*				Comments
		Comments				
The DUT has Digital tuner?	Y / N					
->Please write two typical Digital Service Identification(i.e. ["Service Identification Method"] ["Digital Broadcast System"] ["Service Idetification"]) that the DUT can display and how to select the service using the DUT's control.						(7bytes for Digital Service Identification)
						(7bytes for Digital Service Identification)
The DUT has Analogue tuner?	Y / N					
->Please write two typical Identifier(i.e. ["Analogue Broadcast Type"] ["Analogue Frequency"] ["Broadcast System"]) that the DUT can display and how to select the service using the DUT's control.						(4bytes for Analogue Service Identification)
						(4bytes for Analogue Service Identification)
Can DUT be brought out of Standby?	Y / N					
->Supported Opcode for bringing out of Standby. (example. <Image View On>, <Text View On>)						
Can the DUT send two consecutive messages.?	Y / N					
-> A typical operation for sending two consecutive messages.						
One Touch Play	Support? (Y / N)	Y (Mandatory Feature)				
Does DUT(TV) have an internal source?	Y / N					
Does DUT(TV) have a text mode?	Y / N					
If Y, describe how this mode is entered and how entry is confirmed:						
<Active Source>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Image View On>		Y / N		Y / N		

CEC Feature	Choices	Value				Comments
CEC Message		Support as Initiator?		Support as Follower?		Comments
		Choices	Value	Choices	Value	
	Choices	Value				Comments
		Comments				
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Text View On>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
Routing Control	Support? (Y / N)	Y (Mandatory Feature)				
<Request Active Source>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Routing Change>		Y / N		Y / N		
-> Condition / Instruction for Initiator? (A typical instruction for changing input port.)						
-> Condition / Instruction for Follower? (Can the DUT indicate anything of changing input?)						
<Routing Information>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Set Stream Path>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
-> If we can select a source device via the DUT's menu. A typical operation for select a source via its menu.						
<Inactive Source>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
Standby	Support? (Y / N)					
<Standby>(Directly Addressed)		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower? (Won't turn to standby while recording, etc.)						
<Standby>(Broadcast)		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower? (Won't turn to standby while recording, etc.)						
One Touch Record	Support? (Y / N)					
<Record Off>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						

CEC Feature		Choices	Value				Comments
	CEC Message		Support as Initiator?		Support as Follower?		Comments
			Choices	Value	Choices	Value	
		Choices	Value				Comments
			Comments				
	<Record On>["Own Source"]		Y / N		Y / N		
	-> Condition / Instruction for Initiator? (Operation example how to invoke the DUT to send <Record On>)						
	-> Condition / Instruction for Follower? (When is the DUT ready to record? e.g. the DUT is Power On and Media loaded.)						
	<Record On>["Digital Service"]		Y / N		Y / N		
	-> Condition / Instruction for Initiator? (Operation example how to invoke the DUT to send <Record On>)						
	-> Condition / Instruction for Follower? (When is the DUT ready to record? e.g. Power On and Media loaded.)						
	<Record On>["Analogue Service"]		Y / N		Y / N		
	-> Condition / Instruction for Initiator? (Operation example how to invoke the DUT to send <Record On>)						
	-> Condition / Instruction for Follower? (When is the DUT ready to record? e.g. Power On and Media loaded.)						
	<Record On>["External Plug"]		Y / N		Y / N		
	-> Condition / Instruction for Initiator? (Operation example how to invoke the DUT to send <Record On>)						
	-> Condition / Instruction for Follower? (A typical instruction for recording external plug as Follower and when is the DUT ready to record?)						
	<Record On>["External Physical Address"]		Y / N		Y / N		
	-> Condition / Instruction for Initiator? (Operation example how to invoke the DUT to send <Record On>)						
	-> Condition / Instruction for Follower? (A typical instruction for recording external Physical Address as Follower and when is the DUT ready to record?)						
	<Record Status>		Y / N		Y / N		
	<Record TV Screen>		Y / N		Y / N		
	-> Condition / Instruction for Initiator? (Operation example for Initiating the feature by the DUT.)						
	-> Condition / Instruction for Follower?						
Timer Programming		Support? (Y / N)					
	<Clear Analogue Timer>		Y / N		Y / N		

CEC Feature	Choices	Value				Comments
CEC Message		Support as Initiator?		Support as Follower?		Comments
		Choices	Value	Choices	Value	
	Choices	Value				Comments
		Comments				
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu.)						
-> Condition / Instruction for Follower?						
<Clear Digital Timer>		Y / N		Y / N		
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu.)						
-> Condition / Instruction for Follower?						
<Clear External Timer>		Y / N		Y / N		
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu.)						
-> Condition / Instruction for Follower?						
<Set Analogue Timer>		Y / N		Y / N		
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu.)						
-> Condition / Instruction for Follower?						
<Set Digital Timer>		Y / N		Y / N		
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu.)						
-> Condition / Instruction for Follower?						
<Set External Timer>[…]["External Plug"]		Y / N		Y / N		
-> Typical an External Plug number						
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu. And how to set External Plug, if required.)						
-> Condition / Instruction for Follower?						
<Set External Timer>[…]["External Physical Address"]		Y / N		Y / N		
-> Typical an External Physical Address						
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu. And how to set External Physical Address, if required.)						
-> Condition / Instruction for Follower?						
<Set Timer Program Title>		Y / N		Y / N		
-> Condition / Instruction for Initiator?(Operation example for initiating the feature via EPG or via menu.)						
-> Condition / Instruction for Follower?						
<Timer Cleared Status>		Y / N		Y / N		
<Timer Status>		Y / N		Y / N		

CEC Feature	Choices	Value				Comments
CEC Message		Support as Initiator?		Support as Follower?		Comments
		Choices	Value	Choices	Value	
	Choices	Value				Comments
		Comments				
System Information	Support? (Y / N)					
Languages Supported (Supported Operands for <Set Menu Language>)	(See ISO/FDIS 639-2)					
<Get Menu Language>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
<Give Physical Address>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Polling Message>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
<Report Physical Address>		Y / N		Y / N		
<Set Menu Language>		Y / N		Y / N		
-> Condition / Instruction for Initiator? (Operation example how to modify the DUT's language setting.)						
-> Condition / Instruction for Follower?						
<Get CEC Version>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<CEC Version>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> CEC Version		1.3a				
Deck Control	Support? (Y / N)					
<Deck Control>		Y / N		Y / N		
->Supported Operands?	0x01 - 0x04					
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Deck Status>		Y / N		Y / N		
-> Supported Operands? (When does the dut send with? e.g. Playing forward CD or DVD for ["Play"])	0x11 - 0x1F					
<Give Deck Status>		Y / N		Y / N		
-> Supported Operands?	"On"/"Off"/"Once"					
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						

CEC Feature	*Choices*	*Value*				*Comments*
CEC Message		*Support as Initiator?*		*Support as Follower?*		*Comments*
		Choices	*Value*	*Choices*	*Value*	
	Choices	*Value*				Comments
		Comments				
<Play>		Y / N		Y / N		
->Supported Operands?	0x05 - 0x25					
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
Tuner Control	Support? (Y / N)					
<Give Tuner Device Status>		Y / N		Y / N		
-> Supported Operands?	"On"/"Off"/"Once"					
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Select Digital Service>		Y / N		Y / N		
-> Condition / Instruction for Initiator? (A typical instruction for Select Digital Service.)						
-> Condition / Instruction for Follower?						
<Select Analogue Service>		Y / N		Y / N		
-> Condition / Instruction for Initiator? (A typical instruction for Select Analogue Service.)						
-> Condition / Instruction for Follower?						
<Tuner Device Status>		Y / N		Y / N		
<Tuner Step Decrement>		Y / N		Y / N		
<Tuner Step Increment>		Y / N		Y / N		
-> Condition / Instruction for Initiator? (A typical instruction for Tuner Step Increment / Decrement on the DUT's local or remote control.)						
-> Condition / Instruction for Follower?						
Vendor Specific	Support? (Y / N)					
-> Vendor ID (issued by IEEE RAC) used by DUT	24 bit IEEE ID			(0x000000-0xFFFFFF)		
-> One typical Vendor ID (issued by IEEE RAC) unacceptable for DUT	24 bit IEEE ID			(0x000000-0xFFFFFF)		
<Device Vendor ID>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Give Device Vendor ID>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Vendor Command>		Y / N		Y / N		

CEC Feature	Choices	Value				Comments
CEC Message		Support as Initiator?		Support as Follower?		Comments
		Choices	Value	Choices	Value	
	Choices	Value				Comments
		Comments				
Can the DUT send a <Vendor Command> to the device whose Vendor ID is different from the DUT's?	Y / N					
-> Condition / Instruction for Initiator to send a <Vendor Command> to the device whose Vendor ID is different from the DUT's?						
<Vendor Command With ID>		Y / N		Y / N		
<Vendor Remote Button Down>		Y / N		Y / N		
<Vendor Remote Button Up>		Y / N		Y / N		
OSD Display	Support? (Y / N)					
<Set OSD String>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
Device OSD Transfer	Support? (Y / N)					
<Give OSD Name>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Set OSD Name>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
-> Device OSD Name	(≤14 ASCII)					
Device Menu Control	Support? (Y / N)					
<Menu Request>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Menu Status>		Y / N		Y / N		
-> Condition / Instruction for Initiator? (What status the DUT send? When does the dut send with?)						
What device can the DUT send to on the state of Device Menu Active?	Recording Device(Y/ N)		Choose "Y" If the DUT can sends after receiving <Menu Status>.			
	Playback Device(Y/ N)					
	Tuner (Y/ N)					
	Audio System(Y/ N)					
-> Supported Operation IDs to send Recording Devices?	(0x00 - 0x75)					
-> Supported Operation IDs to send Playback Devices?	(0x00 - 0x75)					

CEC Feature	*Choices*	*Value*				*Comments*
CEC Message		*Support as Initiator?*		*Support as Follower?*		*Comments*
		Choices	*Value*	*Choices*	*Value*	
	Choices	Value				Comments
		Comments				
-> Supported Operation IDs to send Tuner devices?	(0x00 - 0x75)					
-> Supported Operation IDs to send Audio System devices?	(0x00 - 0x75)					
-> Condition / Instruction for Follower?						
Remote Control Passthrough	Support? (Y / N)					
<User Control Pressed>		Y / N		Y / N		
<User Control Released>		Y / N		Y / N		
What device can the DUT select as the target device for remote control pass through?	Recording Device(Y/ N)		Choose "Y" If the DUT can select as the target device for remote control pass through. (e.g. ["Record"] for Recording Deivce)			
	Playback Device(Y/ N)					
	Tuner (Y/ N)					
	Audio System(Y/ N)					
-> Supported Operation IDs to send Recording Devices?	(0x00 - 0x75)					
-> Supported Operation IDs to send Playback Devices?	(0x00 - 0x75)					
-> Supported Operation IDs to send Tuner devices?	(0x00 - 0x75)					
-> Supported Operation IDs to send Audio System devices?	(0x00 - 0x75)					
-> Supported Operation IDs as Follower?	(0x00 - 0x75)					
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
Power Status	Support? (Y / N)	Y (Mandatory Feature)				
<Give Device Power Status>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
<Report Power Status>		Y / N		Y / N		
Feature Abort	Support? (Y / N)	Y(Mandatory Feature)				
<Feature Abort>		Y / N	Y	Y / N	Y	
<Abort>		Y / N	N	Y / N		
System Audio Control	Support? (Y / N)					
<Give Audio Status>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						

CEC Feature	Choices	Value				Comments
CEC Message		Support as Initiator?		Support as Follower?		Comments
		Choices	Value	Choices	Value	
	Choices	Value				Comments
		Comments				
-> Condition / Instruction for Follower?						
<Give System Audio Mode Status>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Report Audio Status>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						
<Set System Audio Mode>		Y / N		Y / N		
-> Condition / Instruction for Initiator? Operation example for activating to "On" by the DUT. Operation example for activating to "Off" by the DUT.						
-> Condition / Instruction for Follower?						
<System Audio Mode Request>		Y / N		Y / N		
-> Condition / Instruction for Initiator? Operation example for activating to "On" by the DUT. Operation example for activating to "Off" by the DUT.						
-> Condition / Instruction for Follower?						
<System Audio Mode Status>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower**?**						
Audio Rate Control	Support? (Y / N)					
Supported control range by the DUT	Wide / Narrow / Both					
Instruction for activating feature.						
<Set Audio Rate>		Y / N		Y / N		
-> Condition / Instruction for Initiator?						
-> Condition / Instruction for Follower?						

*1: If Y, setting instruction and confirmation method are needed.