

2007

HDMI Developers Conference

Shenzhen, China

Update on HDCP Compliance Testing

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What is HDCP?

High-bandwidth Digital Content Protection
encrypts data over HDMI

HDCP helps bring high-definition digital
content to consumers by providing copy
protection over HDMI

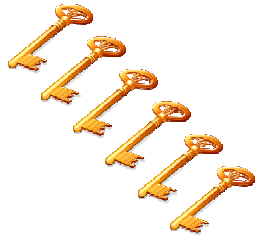
Protected
Content



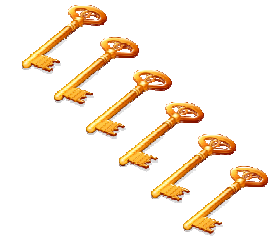
HDCP Protects
this Interface



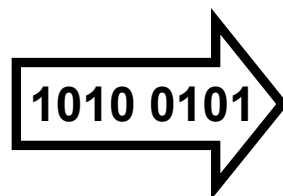
HDCP Basics



1. Public Keys
Exchanged



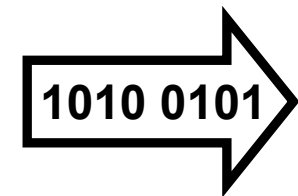
2. Private Keys
create secret
cipher



3. Data
encrypted
with cipher



4. Data
decrypted
with cipher



What is HDCP Compliance Testing

- Test to the requirements of HDCP Compliance Test Specification Rev. 1.1 (the CTS)
- A set of tests that each licensed device must pass
- Tests check if encryption is enabled and disabled as it should be
- Includes Normal operation and Error conditions

HDCP Compliance does not include...

- Not a Certification
- No Logo or warranty
- Does not guarantee devices will interoperate

...That's what Interoperability Workshops are for

Interoperability Workshops (Plugfests)

- Device manufacturers meet at a hotel
- Test sessions are scheduled by device type i.e. Sources with Sinks, Sources with Repeaters...
- Each test session is one hour
- Sessions are private, one on one, NDA required
- Plugfest is private, no Press allowed

Next CEA/HDCP Plugfest:

29 Oct. – 2 Nov.

Embassy Suites Hotel

Milpitas, California

Why test for HDCP Compliance?

- It is required by the license agreement
 - Licensed devices must meet the requirements of the HDCP Specifications
 - See License Agreement Exhibit C Compliance Rules
- “Pass” from Authorized Test Center (ATC) allows device listing on web site
 - Devices can be “family” tested, one test covers many products
- Major retailers want only tested devices

Tested Sink Devices

[Go Back to HDCP Testing](#)

Manufacturer	Product or Family Model	Product Description	Image	Link
Panasonic	TH-42PX75U, TH-50PX75U, TH-58PX75U, TH-42PX77U, TH-50PX77U, TH-50PZ700U, TH-58PZ700U	Plasma TV with two HDMI inputs		
Panasonic	TH-50PZ750U, TH-58PZ750U, TH-65PZ750U	Plasma TV with three HDMI inputs		
JVC	<<< EU >>> LT-46DZ7BJ,BU,BSW LT-46Z70BU LT-26,32,37R70BU,SU LT-26,32,37DR7BU,SU LT-26,32,37DR7BJ,SJ LT-26,32,37DR7BSW,SSW LT-26,32,37DR71SJ,BJ LT-26,32,37R71SU,BU LT-26,32X70BU,SU LT-26,32DX7BJ,SJ	LCD display with two HDMI inputs		<u>Product Information</u>

What are the Requirements?



Can I self-test?	Is there a Logo?	Can I list product on a Web Site?
Yes	No	Yes
Yes	No	Yes

1. Device must Pass at HDMI and HDCP ATC before it goes to Simplay
2. No self-testing
3. Simplay has a logo program
4. Product can be listed on web site

HDMI/ HDCP ATCs Worldwide

Silicon Image ATC
Shanghai, PRC

Sony ATC
Tokyo, Japan

Silicon Image ATC
Shenzhen, PRC

Panasonic FVL
Osaka, Japan

Silicon Image ATC
Germany

HDCP Lab
Oregon
HDCP Only

NXP ATC
France

Silicon Image ATC
California

HDMI, too!

DCP LLC HDCP Lab

- No charge to licensed Adopters
- Bring your devices to our Lab, we assist you in testing
- “Pass” means your device meets all the requirements of the Spec. and CTS
- Device can be sent to test for fee

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ATC Test Tools

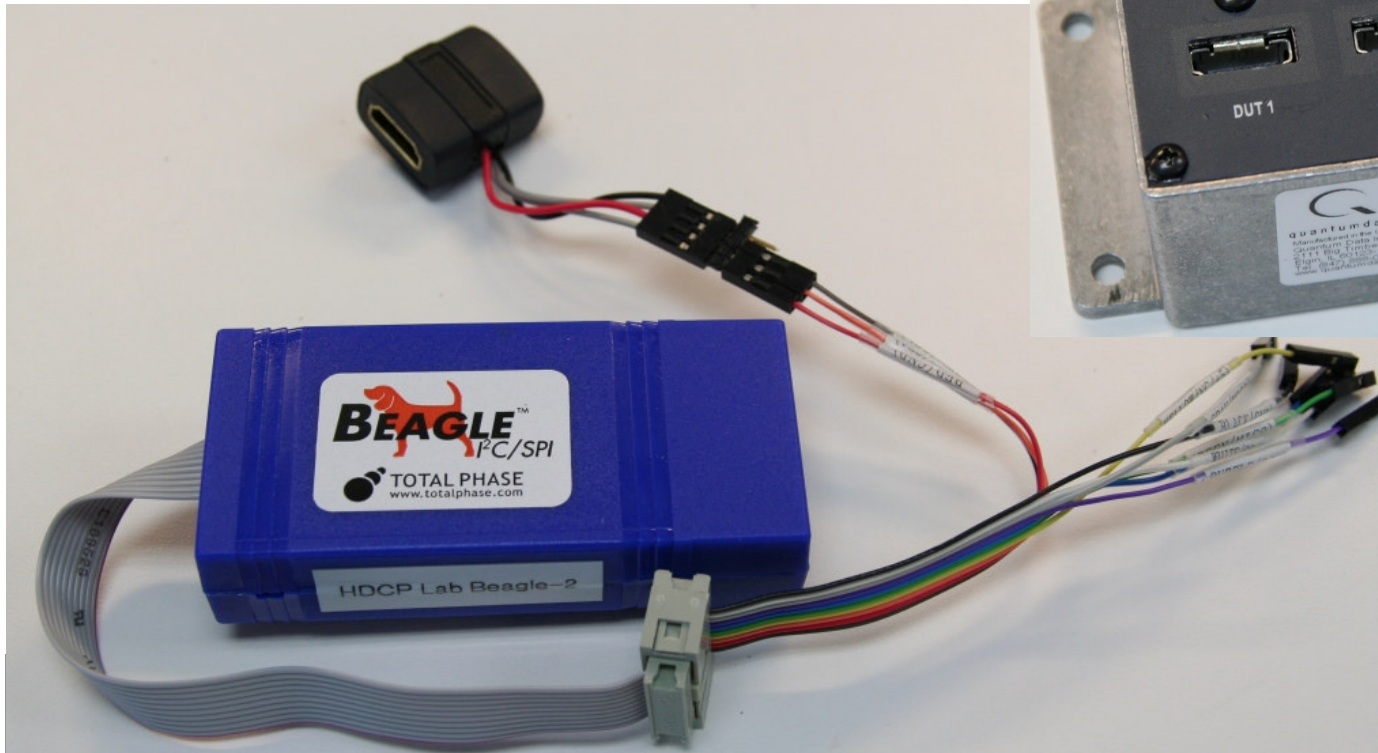
- Panasonic Universal Interoperability Test Analyzer - UITA-2000
- Only available to ATCs
- Performs all 1A, 1B, 2C, 3A, 3B, 3C tests in the CTS



Other Test Tools

Not required, but essential...

- I2C Analyzer (low speed serial interface)
- HDCP Protocol is done using DDC, same as I2C



Total Phase - Beagle Data Center - Untitled (modified)

File Beagle Help

Connection 1095-557682 I2C Settings 100 ns Capture 10 KB Scroll Hide Filters

All USB I2C SPI

Index	min:sec.ms.us.ns	Prot	Len	Data
20	0:13.500.892.600	I2C	3	74 15 00
21	0:13.501.532.100	I2C	2	FF 00
22	0:13.501.623.300	I2C	10	74 18 23 4E 17 C5 3B 22 A8 68
23	0:13.502.930.400	I2C	2	FF 00
24	0:13.503.021.700	I2C	7	74 10 2A 64 75 64 BD
25	0:13.504.036.100	I2C	2	FF 00
26	0:13.504.127.300	I2C	2	74 41
27	0:13.504.340.700	I2C	3	75 00 10
28	0:13.504.973.000	I2C	2	FF 00
29	0:13.505.064.300	I2C	2	74 40
30	0:13.505.277.600	I2C	2	75 80
31	0:13.505.812.500	I2C	2	FF 00
32	0:13.505.903.700	I2C	2	74 00
33	0:13.506.117.100	I2C	6	75 83 03 FD 32 6D
34	0:13.699.193.100	I2C	2	FF 00
35	0:13.699.284.300	I2C	2	74 08
36	0:13.699.497.700	I2C	3	75 D5 39
37	0:13.882.827.000	I2C	2	FF 00
38	0:13.882.918.300	I2C	2	74 08
39	0:13.883.131.600	I2C	3	75 D5 39
40	0:14.233.336.600	I2C	2	FF 00
41	0:14.233.427.900	I2C	2	74 08
42	0:14.233.641.300	I2C	3	75 D5 39
43	0:14.569.817.000	I2C	2	FF 00
44	0:14.569.908.200	I2C	2	74 08
45	0:14.570.121.000	I2C	2	75 D5 39

General Data Filters

Minimum index:

Maximum index:

Minimum length:

Maximum length:

Data pattern:

Show collapsed: ☒

Show info: ☒

Protocols: ☒ USB ☒ I2C ☒ SPI

Write An

Write Aksv

Read Bstatus

Read BCAPS

Read Bksv

Read R0'

Typical DDC (I2C) Trace Showing First Part of Authentication

Why Do We Start Like This...



And End Like This?



Device Interaction makes this hard

- Devices that are compliant may not work together (interoperate)
- CTS defines the procedure and test cases, not all possible DUT behavior
- TE Results require interpretation, especially “FAIL”
- DUTs often do things we don't expect...

When does it Pass or Fail?

It all depends...

- Run each test multiple times
- One-time failures are not uncommon
 - Noise on lines, DDC errors possible causes
- Several Passes, few Fails= Pass

Use other resources

- Compare I2C traffic with Test Result
- See if problem shows in Interoperability Tests

Top Reasons for CTS Fail

- Source must respond to Hot Plug Detect
 - Must re-start authentication
 - Some DUTs check Bksv, Ri' and keep going - Fail
- Source DUT does not work with Repeater
 - This is not an option, it is a **Requirement**
- Not responding to Max_Device_Exceeded and Max_Cascade_Exceeded, or more Ksvs than DUT can handle

Recommendations

- Must be able to read and understand the EDID (especially in devices that merge other device EDIDs i.e. Repeaters)
- Must recognize Hot Plug pulse width of 100 ms and react accordingly
- After writing Aksv, devices must wait for at least 100 ms before reading Ri'.

For interoperability sake - wait for more than 100 ms (perhaps 125). It's not a race!
Give the downstream device a chance to compute it.

Recommendations

- Play unencrypted video into downstream device for a few frames before reading HDCP registers.
Many downstream devices will not make registers stable until they see pixel clocks.
- Some downstream devices use small microcontroller devices
 - Protocol does not require to read messages two or three times per millisecond.
 - Give the downstream microcontrollers a break! It will enhance operability.
 - One frame of video is ~16 milliseconds, no need to be faster!

Recommendations

- Don't use DDC while Hot Plug is de-asserted
 - Downstream may be busy initializing or other
- Too many DDC reads i.e polling BCAPS or Ri' can cause downstream device issues



The Hardest Part

Learning all those remote controls!

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Thank You



Glossary of HDCP Terms

- Authorized Test Center (ATC)
- Authorized Test Tool (ATT)
- Beagle: Total Phase Beagle is a device for reading or tracing data on the DDC interface (also called I2C traffic) used to communicate control signals between devices on the HDMI or DVI interface
- CTS: The HDCP Compliance Test Specification, Current Revision is 1.1
- DCP, LLC: The Digital Content Protection Agency, L.L.C., licensing agency for HDCP. A subsidiary of Intel Corporation
- DUT: Device Under Test
- Downstream: connections made to the DUT on its Output Ports

Glossary of HDCP Terms

- HDCP: High-bandwidth Digital Content Protection system.
- Repeater: An HDCP Device that can receive and decrypt HDCP Content through one or more of its HDCP-protected Interface Ports, and can also re-encrypt and emit said HDCP Content through one or more of its HDCP-protected Interface Ports
- Sink: A Presentation Device (display)
- Specification (Spec.): The HDCP Specification. Current Revision is 1.3
- Source: A device which transmits HDMI or DVI signals
- Test Equipment (TE): Panasonic UITA-2000, High-bandwidth Digital Content Protection Protocol Analyzer
- Upstream: connections made to the DUT on its Input Ports.