HT-180 Handshake Tester

for HDMI

Quick Start Guide

quantumdata

HT-180 assists in troubleshooting and trouble resolution of HDMI-related connection problems:

- Localizes HDCP interoperability failures
- Identifies bad EDIDs
- Indicates improper connection “hot-plugs”

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Overview

The HT-180 Handshake Tester for HDMI assists in troubleshooting of HDCP, EDID and Hot Plug related problems. It also enables you to monitor the HDCP transactions during HDCP compliance testing with the 882 HDCP compliance test application. The LCD user interface provides simple reason codes to identify suspect equipment. Additionally, the HT-180 can monitor and collect I2C transactions to be used with the Auxiliary Channel Analyzer for on-site or post analysis of HDMI system problems or for monitoring HDCP transactions during HDCP compliance testing with the Quantum Data 882 test instrument.

For collecting and viewing I2C transactions there are two PC-based programs, each with a graphical user interface (GUI). The first program, HT180GUI.jar, lets you organize customer and equipment information for each test, and saves test traces for analysis. The second program, QDAca. jar, allows you to view and analyze details of these test traces.

The HT-180 can also be used standalone. In this case the test results are limited to reason codes viewable on its display. To use the HT-180 in standalone mode, see **Standalone Testing**.

About the Tests

Tests can be run in two general physical configurations:

1. With an HDMI source device (such as a DVD or STB) connected directly to 1. an HDMI sink device (typically a TV). In this case a short HDMI cable (provided) is looped between the two middle HDMI connectors on the HT-180.
   or ...
2. With an HDMI source device (such as a DVD or STB) connected through an 2. HDMI repeater device to a HDMI sink device.

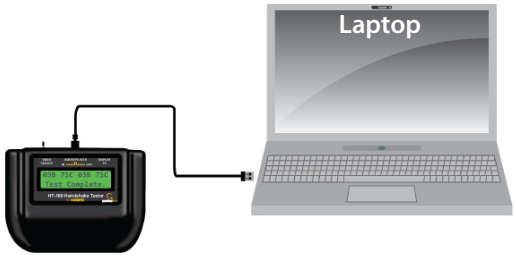
REPRODUCING INTEROPERABILITY PROBLEMS

If you know the precise configuration and sequence of operations that causes a video interoperability problem, you can repeat this sequence during the test. However, there are additional actions you may wish to take during the test of any particular configuration that may bring to light particular problems. The following are some of the actions you can perform during each test that are useful during troubleshooting of your HDMI system:

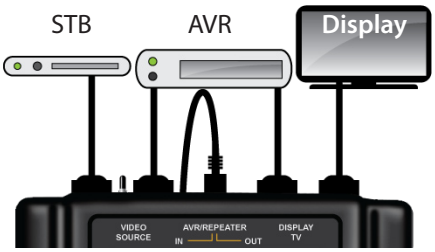
- Disconnect and reconnect the sink HDMI cable to cause a hot plug on thedownstream.
- Disconnect and reconnect the source HDMI cables to cause hot plugs on both the upstream and downstream.
- Power down and then power back up the devices in the system individually.
- Power down all the devices in the HDMI system and then power them back up from upstream to downstream.
- Power down all devices in the HDMI system and then power it back up from downstream to upstream.
- Swap out HDMI devices in the system one at a time and retest.

Making Physical Connections

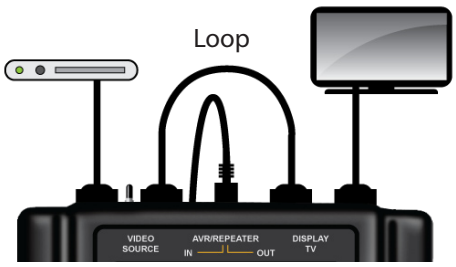
Step 1: Connect the HT-180 to PC via USB.



Step 2: Connect the HDMI cables into the HT-180 from the test devices into their respective inputs.



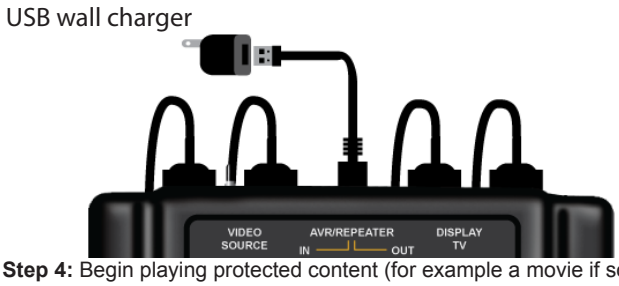
Note: If you are not using an Audio-Video Receiver (AVR) or repeater, loop an HDMI cable between the HT-180's AVR IN to AVR OUT connectors.



Standalone Testing (without a PC)

STARTING THE TEST:

Step 1: Apply power to all video equipment in the HDMI system under test.
Step 2: Connect the HDMI cables into the HT-180 from the test devices into their respective inputs. (Refer to Making Physical Connections)
Step 3: Connect the HT-180 to USB power adapter.



Step 4: Begin playing protected content (for example a movie if source is a DVD player.)
Step 5: Press and release the Test button to start test. Press the Test button to stop test or wait for time out (90 seconds).
Step 6: After performing a test, the HT-180 will display reason codes across the top of its display. The codes consist of a symptom number, followed by a letter that indicates likelihood of an interoperability problem. The meaning of the reason codes are provide in this Quick Reference Guide.
Step 7: Optionally repeat the test, using alternate actions described above reproducing interoperability problems.

Testing with a PC to Capture Traces

SOFTWARE INSTALLATION

Windows 2000

Step 1: Download HT-180 GUI from www.quantumdata.com/downloads/index.asp
Step 2: Unzip and download file.
Step 3: In the folder of unzipped files, double-click on install.bat to install USB driver.
Step 4: Connect HT-180 to PC.
Step 5: If you get a prompt asking you whether or not to overwrite the newer file, click on *No*.
Step 6: Launch HT180Gui.jar from the unzipped folder and follow the latest HT-180 Quick Start Guide available at www.quantumdata.com/downloads/index.asp

Windows XP

Step 1: Download HT-180 GUI from www.quantumdata.com/downloads/index.asp
Step 2: Unzip and download file.
Step 3: In the folder of unzipped files, double-click on install.bat to install USB driver.
Step 4: Connect HT-180 to PC. The *Found New Hardware Wizard* box will appear.
Step 5: Select *Install from a list or specific location*; (Advanced)
Step 6: Click on *Next*.
Step 7: Click on *Browse* and select the folder of unzipped files from the download.
Step 8: Click on *Next*.
Step 9: If you get a prompt asking you whether or not to overwrite the newer file, click on *No*.
Step 10: Click on *Finish*.
Step 11: Launch HT180Gui.jar from the unzipped folder and follow the latest HT-180 Quick Start Guide available at www.quantumdata.com/downloads/index.asp

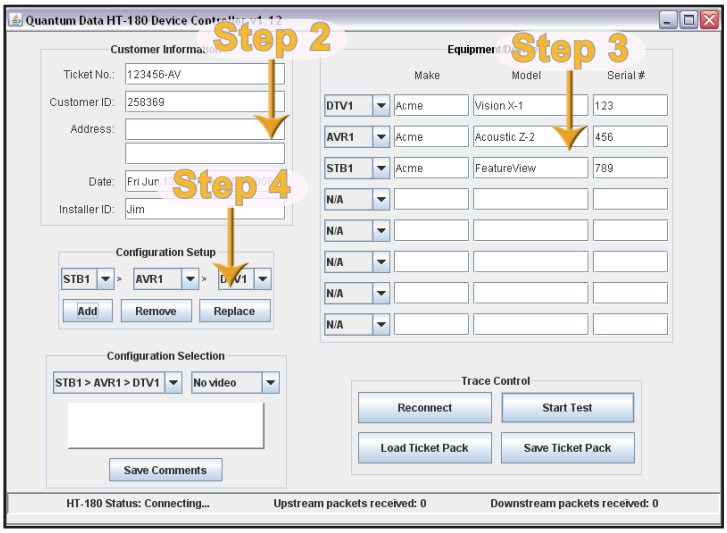
Windows Vista

Step 1: Download HT-180 GUI from www.quantumdata.com/downloads/index.asp
Step 2: Unzip and download file.
Step 3: In the folder of unzipped files, double-click on install.bat to install USB driver.
Step 4: When prompted, click on *Install this driver software anyway*.
Step 5: Connect HT-180 to PC. You will get the *Found New Hardware dialog* box.
Step 6: Click on *Locate and install driver software (recommended)*.
Step 7: Click on *Browse my computer for driver software (advanced)*
Step 8: Browse to the folder of unzipped files from the download.
Step 9: Click on *Next*.
Step 10: When prompted, click on *Install this driver software anyway*.
Step 10: Click on *Close*.
Step 12: Launch HT180Gui.jar from the unzipped folder and follow the latest HT-180 Quick Start Guide available at www.quantumdata.com/downloads/index.asp

SITE CONFIGURATION

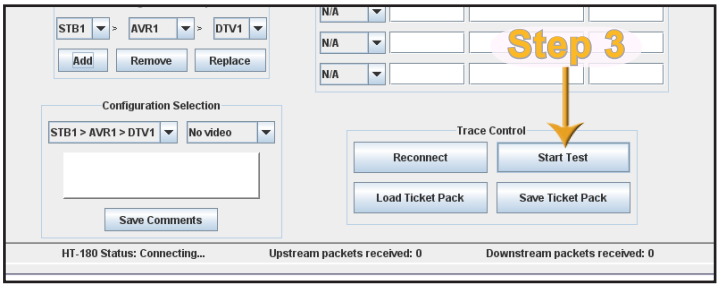
Step 1: Launch the HT-180 Device Controller by double clicking on HT180GUI.jar. (see note 1)
Step 2: Under Customer Information enter at least the Ticket No. and Customer ID. (You can define these, but note that the Ticket No. will be used to name the files on the PC.)
Step 3: Under Equipment/Devices enter device details of your HDMI system under test.
Step 4: Under Configuration Setup, build your configuration, click Add.

Note 1: *The HT-180 programs require that the Java Runtime Environment (JRE) is installed on the PC. We recommend version 1.5.06. If the PC does not have the JRE, you may download it for free at http://java.com/en/dowdload/index.jsp?cid=jdp81312*

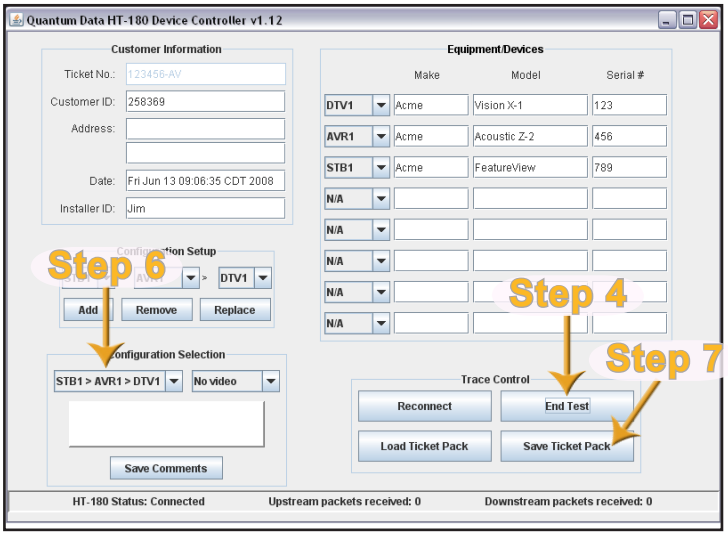


Initiate Test

Step 1: Connect the HT-180 to HDMI system (refer to Making Physical Connections)
Step 2: Complete the steps under Site Configuration.
Step 3: On the PC, under Trace Control, click on the Restart Test button. On the PC, the bottom of the Device Controller window will show packet counts, which will increase during the test.
Do not use the Test button on the HT-180 when connected to PC.

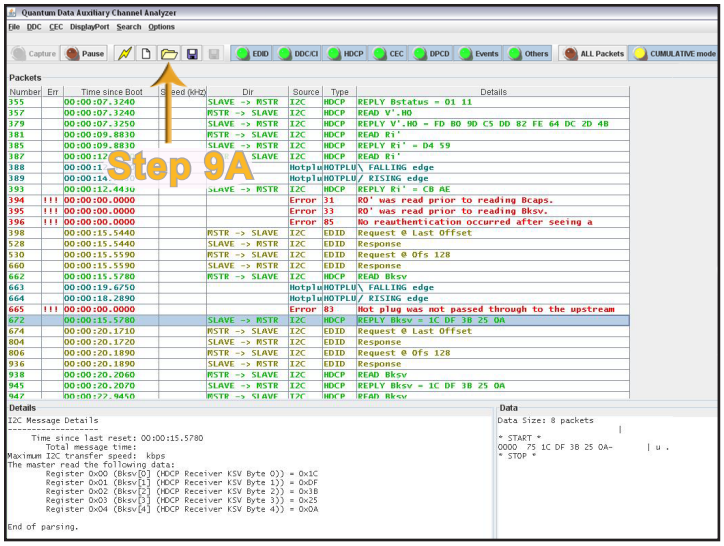


Step 4: Stop the test by pressing the Stop Test button on the HT-180 GUI application, or wait for the test to time out (90 seconds).
Note: The Reconnect Button is used if the HT-180 is powered down.
Step 5: When the test is complete, the Device Controller on the PC will stop and disconnect. (Watch for Test complete message in HT-180 display.)
Step 6: Under *Configuration Selection*, select the configuration and video status. Optionally, enter extra comments and click *Save Comments*.
Step 7: On the PC, under *Trace Control*, click on *Save Ticket Pack* to save trace data to be viewd later.
Step 8: Run the ACA by double-clicking on QDAca.jar (see note 1)



Initiate Test (Continued)

Step 9: To open a trace file:
Step 9A: Click on the file folder icon
Step 9B: Browse to the HT-180 folder
Step 9C: Select the folder corresponding to the ticket number. Click Open
Step 9D: Select one of the traces (downstream traces contain “dn”, and upstream traces contain “up” in the filename.) Click Open



Step 10: To view ticket information, device configuration, and comments related to the ticket:
- In HT-180GUI, enter Ticket No. and click Load

Or
- In Windows Explorer, browse to the ticket folder under the HT-180 folder
- Double-click on the HTML file to view the information in your web browser

Reason Codes

LEGEND:
A = Reason codes with “A” appended to it is very likely to cause interoperability problem.
B = Reason codes with “B” appended to it is likely to cause interoperability problem.
C = Reason codes with “C” appended to it is somewhat likely to cause interoperability problem.
D = Reason codes with “D” appended to it is not likely to cause interoperability problem.

Code	Symptom
---	No error.
1	EDID header incorrect.
2	Bad EDID checksum.
3	Source never read EDID.
4	Source never finished reading EDID.
5	Source attempted to read EDID when hot plug was low.
6	TV/Display did not allow EDID read when hot plug was high.
7	Large EDID claimed but E-DDC not supported by TV/Display.
8	EDID was not read after new hot plug detected.
9	EDID read attempt by source crossed 256-byte boundary.
10	Bad Aksv (does not have 20 ones and 20 zeroes) detected.
11	Bad Bksv (does not have 20 ones and 20 zeroes) detected

Code	Symptom
12	Facsimile Aksv detected.
13	Facsimile Bksv detected.
14	No HDCP attempted on stream.
15	HDCP register read attempted when hot plug was low.
16	HDCP register read not acknowledged when hot plug was high.
17	Aksv was written before An.
18	The last byte of Aksv
19	Aksv was sent multiple times.
20	KSV FIFO was not completely read according to Bstatus DEVICE_COUNT.
21	KSV FIFO read was not a multiple of 5 bytes.
22	KSV FIFO contained a KSV that does not have 20 ones and 20 z eroes.
23	KSV FIFO contained a facsimile KSV.
24	KSV FIFO was read prior to Bstatus.
25	Device read more bytes than existed in the KSV FIFO.
26	KSV FIFO did not contain the downstream device’s Bksv.
27	KSV FIFO was read even though DEV_COUNT was zero.
28	KSV FIFO was read prior to FIFO READY bit being seen.
29	HDCP transaction attempt crossed 256-byte boundary.
30	Source read R0’ from TV/Display before 100ms had elapsed after Aksv write.
31	R0’ was read prior to reading Bcaps.
32	R0’ was read without an Aksv being written.

Reason Codes (Continued)

Code	Symptom
33	R0' was read prior to reading Bksv.
34	Ri' mismatch appears to be the cause of reauthentication.
35	R0' mismatch appears to be the cause of reauthentication.
36	Source device reads R0'/Ri' using short reads.
37	HDCP authentication not seen.
40	Bcaps reserved bits are non-zero.
41	Bcaps' KSV FIFO READY bit was not set to 1 in time.
42	Source did not attempt reauthentication when Bcaps:READY bit was not set.
43	Downstream device authentication failure was not communicated to the up stream.
44	Bcaps was not polled for KSV FIFO READY bit.
45	Bcaps' KSV FIFO READY bit being set to 1 appears to cause reauthentication.
50	Bstatus had MAX_DEVICES_EXCEEDED bit set.
51	Bstatus had MAX_CASCADE_EXCEEDED bit set.
52	Bstatus reserved bits are non-zero.
53	Bstatus HDMI_MODE bit is not set.
54	Bstatus HDMI_MODE is set but Bcaps' HDMI status has not been determined.
55	Bstatus reports that no devices are connected when one is detected.
56	Source does not continue authentication after seeing Bstatus DEVICE_COUNT of zero.
57	Downstream reports that it has too many devices attached but upstream does not see this.
60	Ainfo advanced ciphering enabled when TV/Display did not indicate support for it.
61	Ainfo reserved bits are non-zero.
62	Ainfo was written after Aksv.
64	V' was read prior to reading Bstatus.

Code	Symptom
65	V' was read prior to Bcaps KSV FIFO READY bit.
67	Downstream authentication occurred prior to upstream.
68	Downstream reauthentication is occuring without notifying the upstream with hot plugs.
69	Constant reauthentication was detected
70	Source appeared to stop polling for Ri' values.
71	DDC traffic does not contain STOPs when it should.
72	DDC traffic did not include a START directly after a proper NACK or STOP.
73	EDID was written to by the source device.
74	DDC buffer overflowed.
75	Unknown DDC traffic seen on bus.
76	EDID segment address written without actual segment.
77	DDC event buffer overflowed.
78	TV/Display device does not support E-DDC transactions.
79	Depends on the specific type of error.
80	Hot plug pulses below 100ms in length were detected.
81	Hot plug never went high during test period.
82	Hot plug pulse was not passed to the upstream from the downstream.
83	Hot plug was not passed through to the upstream within 5 seconds.
84	Authentication stopped after seeing a proper hot plug pulse.
85	No reauthentication occurred after seeing a proper hot plug pulse.
87	Current pull on +5v line was measured to be too high
88	Voltage on +5v line was measured to be too low.
89	Voltage on +5v line was measured to be too high.

* These reason codes indicate HDCP compliance violations. The HT-180 is not a substitute for the 882E HDCP compliance test but does verify some of the compliance tests. Quantum Data recommends running the 882E-based HDCP compliance test prior to interoperability testing with the HT-180.

Corrective Actions

In the event of an interoperability problem, we recommend taking the following steps in the order provided.

1	Disconnect and reconnect a cable on the downstream display device to induce a hot plug and then retest.
2	Disconnect and reconnect the cable on the upstream (sink side) of the repeater (if there is one) to induce a hot plug and then retest.
3	Power down all devices in the system and power them back up from downstream to upstream and then retest.
4	Power down all devices in the system and power them back up from upstream to downstream and then retest.
5	Loop out the repeater device if there is one and then retest. (**Note**: the reason codes will be duplicated on the looped output/input)
6	Swap out any long cables with known good cables and then retest.
7	Swap out the source device and then retest.

HDCP Terms

1. **HDCP** - HDCP is an acronym for High-bandwidth Digital Content Protection. HDCP is a protocol which involves an HDMI-HDCP transmitter (a source device such as a DVD or set top box) to authenticate an HDMI-HDCP display device. Once authentication is completed, the source device encrypts the video.

2. **HDCP Authentication -** Authentication is a process that ensures that a display device (e.g. HDTV) is HDCP compliant (an authorized device).
3. **HDCP Encryption** - HDCP Encryption is the encryption technology of HDCP when applied to the protection of HDCP Content in an HDCP System.

4. **HDCP Transmitter (source device)** - An HDCP transmitter is a device that can encrypt and emit HDCP Content through one or more of its HDCP-protected interface ports. The HDCP transmitter is capable plays out protected content over an HDMI cable. Examples are DVD players, set top boxes. **HDCP** - HDCP is an acronym for High-bandwidth Digital Content Protection. HDCP is a protocol which involves an HDMI-HDCP transmitter (a source device such as a DVD or set top box) to authenticate an HDMI-HDCP display device. Once authentication is completed, the source device encrypts the video.

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7. **HDCP Transmitter (source device)** - An HDCP transmitter is a device that can encrypt and emit HDCP Content through one or more of its HDCP-protected interface ports. The HDCP transmitter is capable plays out protected content over an HDMI cable. Examples are DVD players, set top boxes.
8. **HDCP Display Device** - An HDCP display device is an HDMI-HDCP capable device that displays protected content delivered over an HDMI cable. An example is an HDTV.

9. **HDCP Repeater Device** - An HDCP repeater serves as an HDCP receiver on its input side connected to the HDCP transmitter and acts as an HDCP transmitter on its output side connected to one or more HDCP display devices.

10. **Audio/Video Receiver (AVR)** - An AVR is an HDCP repeater device that serves as an audio video processor between an HDMI-HDCP source device and an HDMI-HDCP display device. Audio Video Receiver which is typically connected between an HDMI source device and an HDMI display device. The AVRs act as an HDCP repeater.

11. **HotPlug** - A voltage level signalling system issued from a display device such as a TV, that informs the transmitting device (e.g. DVD or STB) that an HDMI cable has been plugged in. A hot plug event should initiate a reading of the display's EDID and should initiate a new HDCP authentication session.

12. **EDID** - Extended display identification data is a data structure provided by a display devices to describe its capabilities to a source device. The EDID describes its supported formats (resolutions), color modes, audio support, etc to a source devices so that the source device can select the proper video mode.

13. **BCAPS** - The BCAPS is an HDCP register in a display device (e.g. HDTV) that provides information to a source device about the display's capability to support HDCP functions.
14. **BSTATUS** - The BSTATUS is two byte HDCP register in a display device (e.g. HDTV) that provides status information about the display's readiness to continue HDCP authentication and encryption.

15. **An** - a 64-bit pseudo-random value that is used to calculate a session key that is exchanged between two devices to ensure that they are both HDCP compliant.

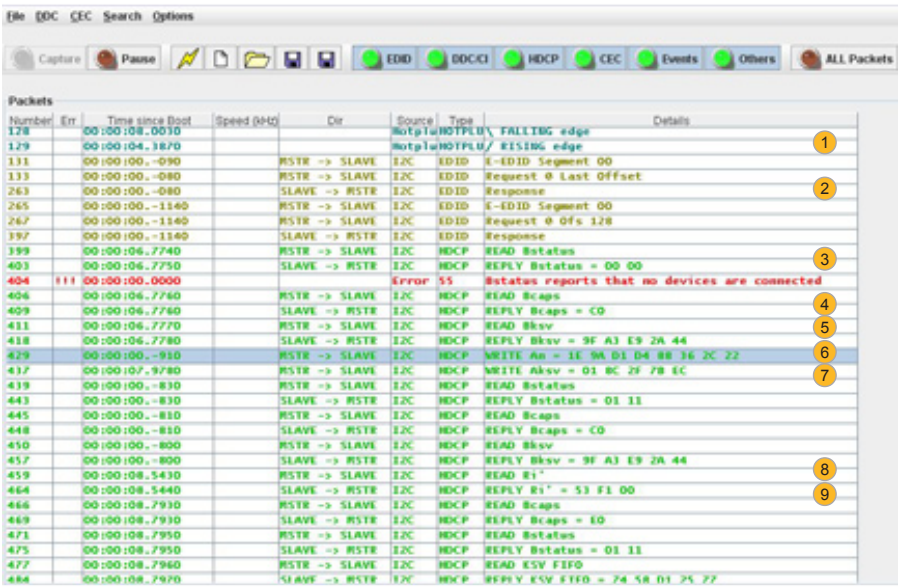
16. **Key Selection Vector (KSV)** - Each HDCP Device contains a set of Device Private Keys. A set of Device Private Keys is associated with a Key Selection Vector (KSV). Each HDCP Transmitter has assigned to it a unique KSV from all other HDCP Transmitters. Also, each HDCP Receiver has assigned to it a unique KSV from all other HDCP Receivers. The BKSV is from the display device (e.g. HDTV) and the AKSV is from the source device (e.g. DVD or STB). The KSV values are used to calculate a session key that is exchanged between two devices to ensure that they are both HDCP compliant. The KSVs are hex values that when converted to binary must have 20 ones and 20 zeros.

17. **Ro** - is a 16-bit response value that the video receiver returns to the HDCP Transmitter to provide an indication as to the success of the authentication exchange. Ro must be available for the HDCP Transmitter to read within 100 milliseconds from the time that the HDCP Transmitter finishes writing Aksv to the video receiver. The HDCP Transmitter must not read the Ro value sooner than 100ms after writing AKSV.

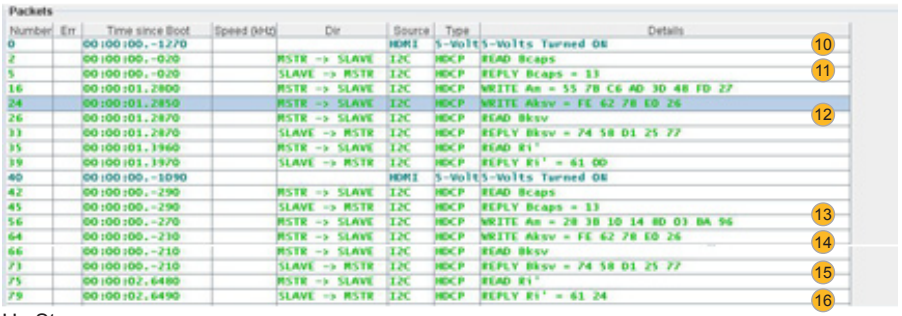
18. **Ri** - is a 16-bit value used for link integrity verification, and is updated for every 128th frame counter increment, starting with 128th.

HDCP Primer - Source – Display

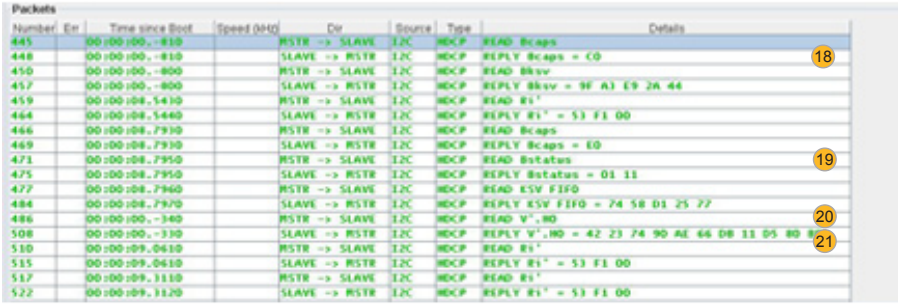
Up Stream

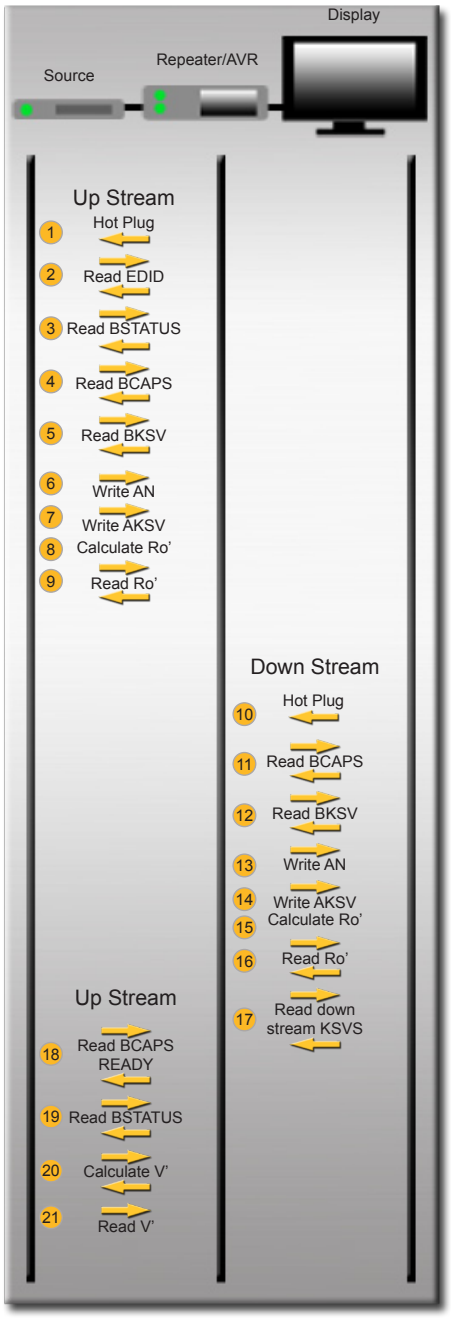


Down Stream



Up Stream





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