HDMI Electrical, Protocol Audio Video (PAV) and Content Protection, HDCP

Application of ZX200 ZX201 ZX201L HDMI electrical testing

Zebax offers high quality HDMI breakout adapters (aka test boards) covering HDMI type A, C and D connector series tailored for sink (receiver) or source (player) HDMI electrical testing. Agilent, Tektronix Lecroy provide suit of oscilloscope automation software and waveform generators enabling engineers meeting the HDMI compliance test requirements. This document describes Zebax ZX200 series HDMI breakout adapters along with description of HDMI electrical tests for reference.

This document identifies:

1. HDMI Breakout adapters
2. HDMI test case summary
3. HDMI Compliance Source Test Cases
4. HDMI Compliance required tools

Revision History

Version	Date	Description
v01	Dec, 22 2011	Initial release –

1 HDMI Breakout, test board

Zebax offers high quality HDMI breakout adapters for use with test equipments from vendors such as Agilent, Tektronix and Lecroy. They are offered supporting both source or sink devices. Additionally Zebax offers HDMI breakout adapters supporting type A (standard) , C (mini)and D (micro) Plug and Socket form factors.

Type A (standard) , C (mini) and D (micro) breakout adapters (test adapter) :

ZX200	HDMI PLUS	TPA-P TDR
*ZX201	HDMI PLUG	TPA-P SE / TPA-P DI
*ZX201L	HDMI PLUG	TPA-P SE / TPA-P DI Tailored for **Lecroy** scope ,

ZX200S	HDMI Socket	TPA-R TDR
*ZX201S	HDMI Socket	TPA-R SE / TPA-R DI
*ZX201SL	HDMI Socket	TPA-R SE / TPA-R DI Tailored for **Lecroy** scope ,

***** Can support both Single ended, SI or Differential Interface, DI , testing.

ZX201L and ZX201SL embed TF-HDMI-3.3V filter which traditionally is required when used with **other** HDMI breakout adapter.

2 HDMI test case summary

High Definition Multimedia Interface, HDMI, is high speed serial interface where uncompressed high definition video is transmitted via 4 data lanes. Table below is summary key HDMI Compliance test categories in receiver (sink), transmitter (source) and the transmission media.

	Application	HDMI	Description
Protocol	Data Rate (Maximum)	3.4GHz	
	Lanes	4 lanes	(Clock + 3 data lanes) Data transitions at 10x of clock speed
	Encoding	8B10B	8b / 10b Signal Encoding methodology pioneered by IBM converting 8 bit data into 10bits Transmission Character, TC. TC provides bit synchronization, improved error detection along with ease of decoding of control characters. Simplified design of transmit
	Signaling	TMDS	Physical layer electrical interface standard - Transition Minimized Differential Signaling, TDMS, with pixel clock of 3.4GHz maximum frequency for 4K resolution.
Receiver Sink Tests	Sensitivity / Amplitude	yes	Multi-stage test process where the voltage levels and signal source stability as measured by the receiver is verified: 1- Differential voltage 2- Eye Height
	Timing Slew	yes	Differential and single ended signal timing as seen by the Sink device
	Jitter Tolerance	yes	Sum of the deterministic and random spectral components as supplied by source + accumulated by the transmission media.
Transmitter Source Tests	Eye diagram	yes	Superimposing multiple, one unit interval (UI) signal captures relative to the reference clock - The Eye Height (amplitude domain) and Eye Width (timing and jitter) shall comply with the required opening, the mask . Excessive jitter, timing and low
	Transmission Timing (Rise/ Fall)	yes	Differential and single ended signal timing as supplied by the Souce.
	Amplitude	yes	Multi-stage test process where the voltage levels and signal source stability through transmission path with load is verified: 1- Differential voltage 2- Eye Height
	Jitter	yes	Sum of generated deterministic and random spectral components by the signal source diving the transmission media + load
Cable Connector Tests	Cross Talk	yes	Signal leakage across differential pairs & inner pairs with isolated ground shielding.
	Transition Timing (Rise / Fall)	yes	Differential pair conductor impedance matching, coupling and cross pairs conductor matching
	Loss	yes	Sum of capacitance and impedance losses attributed to the cable assembly + Connector's insertion loss
	Impedance	yes	Conformance of 50 Ω single ended conductor impedance and 100 Ω differential impedance on the high speed conductor pairs.

3 HDMI Compliance Source Test Cases

Table below is summary of required HDMI Compliance source test cases 1.4 and 1.4b. The table is grouped in EDID, Electrical, PAV, and HDCP categories.

HDMI Specification 1.3c (1.4b)			
HDMI Compliance Source Tests Cases by categories			
Source – EDID/E-DDC/HPD	**Source – Electrical**	**Source – Protocol**	**HDCP**
EDID Test	**Electrical Test**	**Source – Protocol (P/A/V Test)**	
List of Test **Equipments**			
EDID Test Equipment	Electrical Test Equipment	Protocol, Audio, Video (PAV)Test Equipment	HDCP Test Equipment
7-1 - EDID	7-2 - TMDS – V_L 7-3 - TMDS – I_{OFF} 7-4 - TMDS – T_{RISE}, T_{FALL} 7-5 - NA-Remove 7-6 - TMDS – Inter-Pair Skew 7-7 - TMDS – Intra-Pair Skew 7-8 - TMDS – Clock Duty Cycle 7-9 - TMDS – Clock Jitter 7-10 - TMDS – Data Eye Diagram 7-11 - +5V Supply Power 7-12 - Hot Plug Detect 7-13 - DDC/CEC Capacitance, Voltage 7-14 - CEC Line Connectivity 7-15 - CEC Line Degradation	7-16 - Legal Codes 7-17 - Basic Protocol 7-18 - Extended Control Period 7-19 - Packet Types ***Source – Video*** 7-20 - Removed 7-21 - Minimum Format Support 7-22 - Additional Format Support 7-23 - Pixel Encoding – RGB to RGB (Sink) 7-24 - Pixel Encoding – YCBCR to YCBCR (Sink) 7-25 - Video Format Timing 7-26 - Pixel Repetition 7-27 - AVI InfoFrame ***Source – Audio*** 7-28 - IEC 60958 / IEC 61937 7-29 - ACR 7-30 - Audio Sample Packet Jitter 7-31 - Audio InfoFrame 7-32 - Audio Sample Packet Layout ***Source – Interoperability With DVI*** 7-33 - Interoperability With DVI ***Source – Advanced Features*** 7-34 - Deep Color 7-35 - Gamut Metadata Transmission 7-36 - High Bitrate Audio 7-37 - One Bit Audio 7-38 - 3D Video Format timing (1.4b only) 7-39 - 4Kx2K Video Format timing (1.4b only)	**9.2 - HDCP Implementations** shall meet HDCP specification Revision 1.2 **10.2 - HDCP Compliance Test Method** must meet HDCP Compliance Test Specification, Rev. 1.1 ***HDCP Compliance Test Rev 1.1 -*** 1A-01 - With HDMI capable Receiver 1A-02 - HPD after writing Aksv 1A-03 - HDP after starting 3rd **part** of authentication 1A-04 - HDCP port access 1A-05 - Verify Bksv 1A-06 - Verify R0 1A-07 - Verify Ri 1A-08 - SRM 1A-09 - With DVI Receiver 1B-01 - With Repeater 1B-02 - HPD after reading R0 1B-03 - Timeout of KSV list Ready 1B-04 - Verify V 1B-05 - Max-Devs-Exceeded 1B-06 - Max-Cascade-Exceeded 1A-09 - With DVI Receiver
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4 HDMI Compliance required tools

Table below is summary of required tools for HDMI Compliance test.

HDMI Electrical Tests

Vendor	Oscilloscope	Probe	Compliance sw	Waveform Generator	Comments
Tektronix	TDS6804B	P7313SMA	TDSHT3	AWG710B	4 ch. 8GHz bandwidth
	DPO70804C	P7380SMA		AWG7100 AWG7051	13GHz
		TCA-SMA	SMA probe		18GHz
		TCA-292MM	SMA Probe		20GHz
Agilent	DSO80804B	E2694A	N5399A	86105B	4 ch. 8GHz bandwidth
	DSO81304B		N5380A		13GHz, 12, 10 GHz
	DSO81204B				12GHz
	DSO81004B				10 GHz
Lecroy	808Zi-A	SMA	SDA-HDMI		4 ch. 8GHz bandwidth
	813Zi-A				
	816Zi-A				

HDMI Protocl Audio Video, PAV analyzer from Agilent

HDMI Ver.	Tool	
1.4a	N5998A	Older generation which does not cover 4Kx2K & 3D video format timing
1.4b	U4998A	includes **4k x 2K** , **deep color** at max. of 3.4Gbps

HDCP Compliance test tools

	Panasonic	UITA-2000	Universal Interoperability Test Analyzer
	Quantum	882EA	Video Test ersal Interoperability Test Analyzer

Default system requirement for resolutions upto 1080p

TF-HDMI-3.3V is not required when using Lecroy system with Zebax ZX201L or ZX201SL breakout adapters

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