DATA SHEET

N5998A HDMI Protocol/Audio/Video Analyzer and Generator



Features and Benefits

- HDMI 1.4 compliance measurements
- HDMI protocol analysis
- HDMI data generator
- Deep color support
- 3D support in both analysis and generation
- Extended colorimetry and content type support
- Linkage to Keysight logic analyzer for deep analysis

N5998A HDMI Protocol/Audio/Video Analyzer and Generator

The N5998A is the reference high-speed

- protocol analyzer
- video timing analyzer
- video picture analyzer
- audio timing analyzer
- audio/video protocol generator for HDMI compliance tests required by the compliance test specification (CTS 1.4). The global HDMI authorized test centers (ATCs) rely on the N5998A.

The HDMI protocol/audio/video analyzer and generator consists of the following components shown in Figure 1:

- Keysight Technologies, Inc. N5998A unit
- Personal computer running Windows XP with a USB 2.0 port available and connected to the Keysight N5998A unit for downloading the captured TMDS sequences (not included in the product)
- Keysight HDMI software running on the PC with the licenses enabled
- HDMI cable to connect the device under test (DUT) to the N5998A. Cable not provided with the product.

KEYSIGHT TECHNOLOGIES

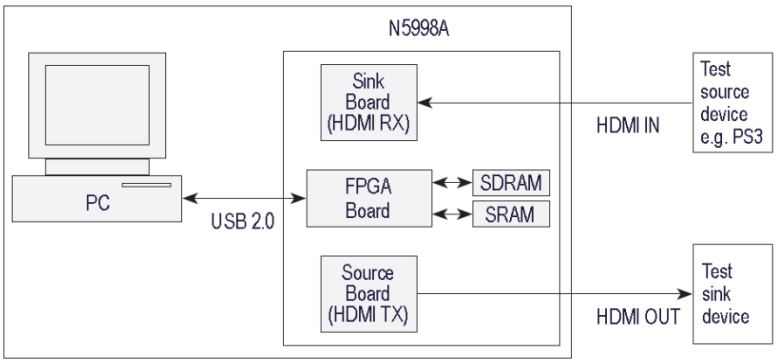


Figure 1. N5998A block diagram

HDMI analyzer features

- User-controlled execution of individual or multiple protocol/audio/video compliance tests
- Clear indication of test PASS/FAIL results, view results in the application or can be saved to an offline text file
- Process captured HDMI data file and shows details of each frame. e.g. the number of packets in the frame and the specific packet types, video data periods, preambles, etc.
- Support for deep color 30-bit, 36-bit and 48-bit
- Detailed decode, view the values of the channel data anywhere in the frame

Note: A frequency counter (not included with the product) is needed to measure the TMDS Clock in conjunction with the N5998A for test 7-25 (Video Format Timing), 7-29 (ACR), 7-34 (Deep Color) and 7-38 (3D Video Format Timing).

HDMI generator features

- Ability to generate protocol and audio pattern, including deep color patterns
- Predefined test patterns are installed with the software installation

Note: For test 8-25 (deep color), both instruments (TMDS Generator as well as N5998A) are needed.

Debug features

- With the N5998U-DBG option, you can import the captured data into the Keysight logic analyzer software for deeper analysis
- For additional test patterns on the generation side, Keysight's partner BitifEye provides an GUI based frame generator tool.

Typical configurations **Hardware**	
N5998A	HDMI 1.3 protocol analyzer and generator. Note: For 1.3 CTS support, no additional software license is required.
Software	
N5998U-R14	Software upgrade to support HDMI 1.4. Note: For support of the 1.4 CTS, this license is required.
N5998U-DBG	Debug export tool - view capture in logic analyzer (optional)
BIT-HDMI- FG-PAG	Frame generator tool (purchase from BitifEye, optional)

N5998A HDMI Protocol/Audio/Video Analyzer and Generator

Protocol/audio/video analyzer

The N5998A's protocol/audio/video analyzer supports the HDMI source compliance tests 7-16 through 7-40, with the exception of tests 7-20, 7-21, 7-22 and 7-39. The protocol analyzer captures up to 4 GB of data as shown in Figure 2. The analysis is then conducted in postprocessing.

Prior to the processing, a data file has to be uploaded, and saved on the controller PC. The CTS source audio tests require the minimum sample time of 2 seconds. The minimum file size to meet this requirement for each primary video format is calculated with the formulas below. Note one pixel is 64 bit (8 Byte) in the target file.

Progressive formats: 2 sec frame size = (H total x V total x 8) x V Freq x 2

Interlace formats: 2 sec frame size = (H total x V total x 8) x V Freq

- The H total, V total and V Freq values are listed in the Video Format Timings 2 of the CEA-861-C CEA Standard
- For 36 bit deep color, multiply by 1.5

Example 720x480p 60 Hz: file size = 858 x 525 x 8 x 60 x 2
= 432,432,000 Byte

A 10 % margin is recommended because the data file does typically not start exactly at the beginning of a frame. Hence a 480 MB file size is required for testing 2 seconds of 720x480p 60 Hz audio data.

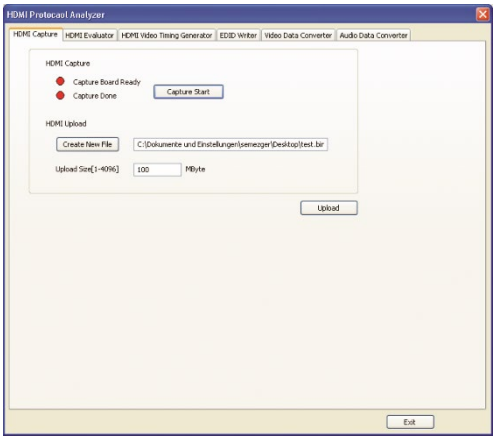


Figure 2. Data capture setup screen

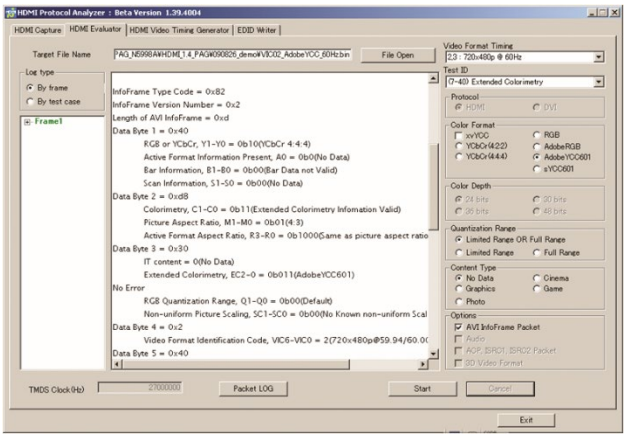


Figure 3. HDMI protocol analysis

Some analyzer tests display the captured video frame during data processing (see Figure 4).



Figure 4. Display of captured video frame

Protocol generator

The N5998A HDMI software provides the pattern required for the sink tests 8-16, 8-21, 8-23, 8-29, 8-31 and, in conjunction with the Keysight TMDS signal generator E4887A, 8-25. An example is shown in Figure 5.

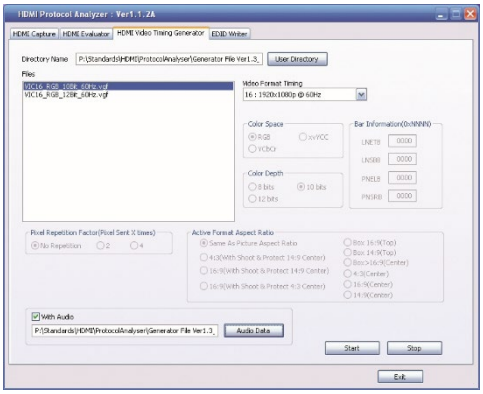


Figure 5. Protocol generator user interface

If you need to generate additional patterns, beyond those defined by the CTS, Keysight in partnership with BitifEye provides a frame generator application. The frame generator (BIT-HDMI-FG-PAG), allows you to define the patterns to generate and automatically sends it out through the N5998A PAG. For more information regarding the frame generator application, please see the related literature section for the datasheet.

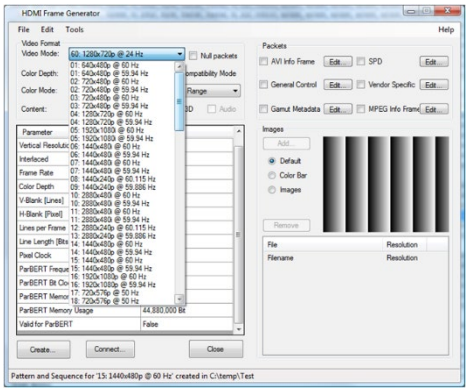


Figure 6. BitifEye frame generator

The PAG capture file is now able to be viewed through the logic analyzer software (N5998U-DGB option required). This enhancement enables the user to export the captured file into a format that can be viewed by the logic analyzer software (no logic analyzer module hardware required). In the logic analyzer software, you will be able to see not only the pixel information, but also see the relationship between the data channels, as well as the control signals, such as V_Sync, H_Sync, video guard band, etc.

The waveform view clearly highlights the relationship between the different signals, and allows for easy navigation through markers and zoom-in/zoom-out capabilities. Other tools for the logic analyzer software such as filter and colorization are also available.

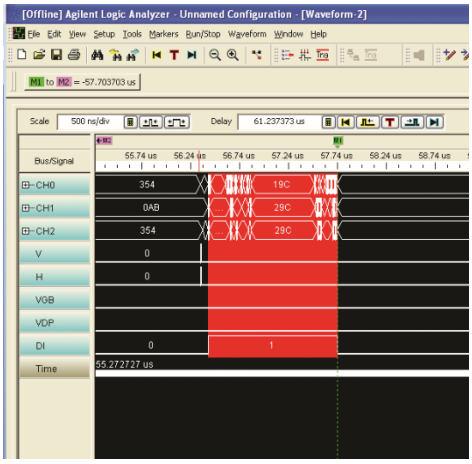


Figure 7. Logic analyzer view of HDMI data and signals

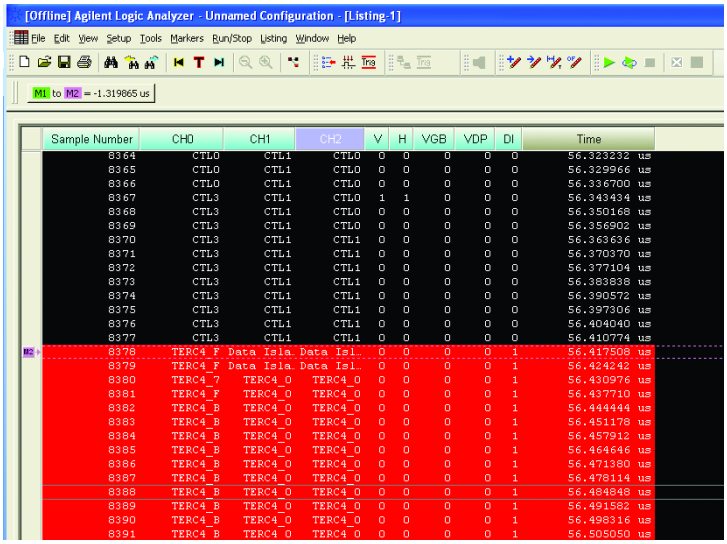


Figure 8

N5998A HDMI Protocol/Audio/Video Analyzer and Generator

Supported CTS tests

Table 1. Supported HDMI CTS 1.4 sink and source tests

Test	Name	N5998A PAG	E4887A TMDS Signal Generator	Quantum Data 882CA
Source protocol				
7-16	Legal Codes	X		
7-17	Basic Protocol	X		
7-18	Extended Control Period	X		
7-19	Packet Types	X		
Source video				
7-23	Pixel Encoding – RGB to RGB Sink	X		
7-24	Pixel Encoding – YCbCr to YCbCr Sink	X		
7-25	Video Format Timing	X		
7-26	Pixel Repetition	X		
7-27	AVI InfoFrame	X		
Source audio				
7-28	IEC 60958/IEC 61937	X		
7-29	ACR	X		
7-30	Audio Sample Packet Jitter	X		
7-31	Audio InfoFrame	X		
7-32	Audio Sample Packet Layout	X		
Source interoperability with DVI				
7-33	Interoperability with DVI	X		
Source advanced features				
7-34	Deep Color	X		
7-35	Gamut Metadata Transmission	X		
7-36	High Bitrate Audio	X		
7-37	One Bit Audio	X		
7-38	3D Video Format Timing	X		
7-40	Extended Colorimetry Transmission	X		
Sink electrical				
8-5	TMDS – Min/Max Diff. Swing Tol.		X	
8-6	TMDS – Intra-Pair Skew		X	
8-7	TMDS – Jitter Tolerance		X	
Sink protocol				
8-15	Char. Synchronization		X	
8-16	Accep. of All Valid Packet Types	X		
Sink video				
8-17	Basic Format Support Req.			X
8-18	HDMI Format Support Req.			X
8-19	Pixel Encoding Requirements		X	X
8-20	Video Format Timing		X	
Sink audio				
8-21	Audio Clock Regeneration	X		
8-22	Audio Sample Packet Jitter		X	
8-23	Audio Formats	X		

N5998A HDMI Protocol/Audio/Video Analyzer and Generator

Supported CTS tests (continued)

Table 1. Supported HDMI CTS 1.4 sink and source tests

Test	Name	N5998A PAG	E4887A TMDS Signal Generator	Quantum Data 882CA
Sink interoperability with DVI				
8-24	Interoperability with DVI		X	
Sink advanced features				
8-25	Deep Color	X	X	
8-29	3D Video Format Timing	X		
8-30	4K x 2K Video Format Timing		X	
8-31	AVI Info Frame supporting extended colorimetry, content type, selectable YCC Quantization Range	X		

Note: For tests 8-19 and 8-25, all instruments indicated are needed

Supported video formats

Table 2.

CEA video ID code	Format	Field rate	Picture aspect ratio	Analyzer					Generator				
				24 bit	30 bit	36 bit	48 bit	3D	24 bit	30 bit	36 bit	48 bit	3D
1	640x480p	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	X	X	T	
2	720x480p	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	X	X	T	
3	720x480p	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	X	X	T	
4	1280x720p	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	X	X	T	X
5	1920x1080i	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	X	X	T	
6	720(1440)x 480i	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	X	X	T	
7	720(1440)x 480i	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	X	X	T	
8	720(1440)x 240p	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	B	B	T	
9	720(1440)x 240p	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	B	B	T	
10	2880x480i	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	B	B	T	
11	2880x480i	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	B	B	T	
12	2880x240p	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	B	B	T	
13	2880x240p	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	B	B	T	
14	1440x480p	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	X	X	T	
15	1440x480p	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	X	X	T	
16	1920x1080p	59.94 Hz/60 Hz	16:9	X	X	X			X	X	X	T	
17	720x576p	50 Hz	4:3	X	X	X	X	X	X	X	X	T	
18	720x576p	50 Hz	16:9	X	X	X	X	X	X	X	X	T	
19	1280x720p	50 Hz	16:9	X	X	X	X	X	X	X	X	T	X
20	1920x1080i	50 Hz	16:9	X	X	X	X	X	X	X	X	T	

Supported video formats (continued)

Table 2.

CEA video ID code	Format	Field rate	Picture aspect ratio	Analyzer					Generator				
				24 bit	30 bit	36 bit	48 bit	3D	24 bit	30 bit	36 bit	48 bit	3D
21	720(1440)x 576i	50 Hz	4:3	X	X	X	X	X	X	X	X	T	
22	720(1440)x 576i	50 Hz	16:9	X	X	X	X	X	X	X	X	T	
23	720(1440)x 288p	50 Hz	4:3	X	X	X	X	X	B	T	T	T	
24	720(1440)x 288p	50 Hz	16:9	X	X	X	X	X	B	T	T	T	
25	2880x576i	50 Hz	4:3	X	X	X	X	X	X	T	T	T	
26	2880x576i	50 Hz	16:9	X	X	X	X	X	X	T	T	T	
27	2880x288p	50 Hz	4:3	X	X	X	X	X	X	T	T	T	
28	2880x288p	50 Hz	16:9	X	X	X	X	X	X	T	T	T	
29	1440x576p	50 Hz	4:3	X	X	X	X	X	X	X	X	T	
30	1440x576p	50 Hz	16:9	X	X	X	X	X	X	X	X	T	
31	1920x1080p	50 Hz	16:9	X	X	X	X	X	X	X	X	T	
32	1920x1080p	23.97 Hz/24 Hz	16:9	X	X	X	X	X	X	X	X	T	X
33	1920x1080p	25 Hz	16:9	X	X	X	X	X	X	T	T	T	
34	1920x1080p	29.97 Hz/30 Hz	16:9	X	X	X	X	X	X	T	T	T	
35	2880x480p	59.94 Hz/60 Hz	4:3	X	X	X	X	X	X	X	X	T	
36	2880x480p	59.94 Hz/60 Hz	16:9	X	X	X	X	X	X	X	X	T	
37	2880x576p	50 Hz	4:3	X	X	X	X	X	X	X	X	T	
38	2880x576p	50 Hz	16:9	X	X	X	X	X	X	X	X	T	
39	1920x1080i	50 Hz	16:9	X	X	X	X	X	B	T	T	T	
40	1920x1080i	100 Hz	16:9	X	X	X			B	T	T	T	
41	1280x720p	100 Hz	16:9	X	X	X			B		T	T	
42	720x576p	100 Hz	4:3	X	X	X	X	X	B	T	T	T	
43	720x576p	100 Hz	16:9	X	X	X	X	X	B	T	T	T	
44	720(1440)x 576i	100 Hz	4:3	X	X	X	X	X	B	T	T	T	
45	720(1440)x 576i	100 Hz	16:9	X	X	X	X	X	B	T	T	T	
46	1920x1080i	119.88 Hz/ 120 Hz	16:9	X	X	X			B		T	T	
47	1280x720p	119.88 Hz/ 120 Hz	16:9	X	X	X			B			T	
48	720x480p	119.88 Hz/ 120 Hz	4:3	X	X	X	X	X	B			T	
49	720x480p	119.88 Hz/ 120 Hz	16:9	X	X	X	X	X	B			T	
50	720(1440)x 480i	119.88 Hz/ 120 Hz	4:3	X	X	X	X	X	B	T	T	T	

N5998A HDMI Protocol/Audio/Video Analyzer and Generator

Supported video formats (continued)

Table 2.

CEA video ID code	Format	Field rate	Picture aspect ratio	Analyzer					Generator				
				24 bit	30 bit	36 bit	48 bit	3D	24 bit	30 bit	36 bit	48 bit	3D
51	720(1440)x 480i	119.88 Hz/ 120 Hz	16:9	X	X	X	X	X	B	T	T	T	
52	720x576p	200 Hz	4:3	X	X	X	X	X	B	T	T	T	
53	720x576p	200 Hz	16:9	X	X	X	X	X	B	T	T	T	
54	720(1440)x 576i	200 Hz	4:3	X	X	X	X	X	B	T	T	T	
55	720(1440)x 576i	200 Hz	16:9	X	X	X	X	X	B	T	T	T	
56	720x480p 240 Hz	239.76 Hz/	4:3	X	X	X	X	X	B			T	
57	720x480p	239.76 Hz/ 240 Hz	16:9	X	X	X	X	X	B			T	
58	720(1440)x 480i	239.76 Hz/ 240 Hz	4:3	X	X	X	X	X	B			T	
59	720(1440)x 480i	239.76 Hz/ 240 Hz	16:9	X	X	X	X	X	B			T	
60	1280x720p	24 Hz		X	X	X	X	X	X				
61	1280x720p	25 Hz		X	X	X	X	X	X				
62	1280x720p	29.7 Hz/30 Hz		X	X	X	X	X	X				
63	1920x1080p	120 Hz		X	X	X	X	X	T				
63	1920x1080p	100 Hz		X	X	X	X	X	T				

T: High resolution TMDS signal converter E4887A Option 007
B: Pattern not pre-installed, requires Option BIT-HDMI-FG-PAG

General system requirements PC system requirements	
Hardware	Pentium processor 1 GHz or equivalent 512 MB available RAM 8 x CD-ROM driver or higher VGA resolution 1024 x 768 5 GB or more free disc space USB 2.0 interface
Operating system	Windows XP

General characteristics	
Power requirements	100 - 240 V~ 300 VA max. 50/60 Hz
TMDS clock output	3.3 V LVTTL
Memory analyzer	4 GB

N5998A HDMI Protocol/Audio/Video Analyzer and Generator

Environment	
Temperature	Operating: 5 °C to + 45 °C Storage: 5 °C to + 45 °C
Humidity	Operating: 15% - 95% @ 40 °C (non-condensing) Storage: 90% @ 65 °C
Safety & EMC standards	IEC 61010-1/EN 61010-1 IEC 61326/EN 61326-1 Installation category II, Pollution degree: 2

Physical characteristics	
2-slot chassis	Width: 43 cm (16.9 in) Depth: 35 cm (13.8 in) Height: 14 cm (5.5 in) Weight: 6 kg (13.2 lbs)

Connectors	
HDMI (input and output)	Type B receptacle
PC controller	USB 2.0
TMDS clock output	BNC

Related Keysight Literature

Publication title	Pub number
Keysight Test Solutions for HDMI Brochure	5989-7169EN
Keysight E4887A HDMI TMDS Signal Generator Platform Data Sheet	5989-5537EN
Keysight N5990A Test Automation Software Platform Data Sheet	5989-5483EN

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