

Data Sheet Version 1.2



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 Agilent logic analyzer for deep analysis



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:

- Agilent N5998A unit
- Personal computer running Windows[®] XP with a USB 2.0 port available and connected to the Agilent N5998A unit for downloading the captured TMDS sequences (not included in the product)
- Agilent 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.

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 Agilent logic analyzer software for deeper analysis
- For additional test patterns on the generation side, Agilent'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)				



Figure 1. N5998A block diagram

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 = $858 \times 525 \times 8 \times 60 \times 2$ = 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 Agilent TMDS signal generator E4887A, 8-25. An example is shown in Figure 5.

ectory Name Pt\Standards\HDMI\ProtocolAnaly s c16_RG8_1087_60Hz.vof c16_RG8_1288C_60Hz.vof	vser\Generator File Ver1.3_ User Directory Video Format Timing 16 : 1920×1080p @ 60Hz	M
Pixel Repetition Factor(Pixel Sent X times) No Repetition 2 4	Active Format Aspect Ratio	Ber Information(0x4NN/N) UNETE 0000 UNSEE 0000 PNELB 0000 PNSEE 0000 Box 16:9(Top) 000:16:9(Center) 0:43(Center) 0:43(Center)
	0 16:9(With Shoot & Protect 4:3 Center)	0 16:9(Center) 0 14:9(Center)
With Audio P:\Standards\HDMI\ProtocolAnalyser\Generator	File Ver1.3_ Audio Data	Start Stop

Figure 5. Protocol generator user interface

If you need to generate additional patterns, beyond those defined by the CTS, Agilent 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.

File Edit	Tools				Help
Video Format	-		-	Packets	
Video Mode:	60: 1280x720p @ 24 H	2	Null packets	m marrie (mar	
Color Depth: Color Mode: Content:	01: 640x480p @ 60 Hz 01: 640x480p @ 59.94 02: 720x480p @ 59.94 02: 720x480p @ 60 Hz 03: 720x480p @ 59.94 03: 720x480p @ 59.94 04: 1280x720p @ 60 Hz	Hz Hz Hz z	ompatibility Mode Range • 3D Audio	General Control Edt	Vendor Specific Edt
Parameter	04: 1280x720p @ 59.9 05: 1920x1080 @ 60 H	4 Hz iz		Images	
Vertical Resolu	05: 1920x1080 @ 59.9 tic 06: 1440x480 @ 60 H	4 Hz		Add	
Interlaced	06: 1440x480 @ 59.94	Hz		Default	
Frame Rate	07: 1440x480 @ 59.94	Hz		Color Bar	
Color Depth	— 08: 1440x240p @ 60.1 09: 1440x240p @ 59.8	15 Hz 86 Hz		C Images	
V-Blank [Lines]	10: 2880x480 @ 60 H; 10: 2880x480 @ 59 94	Hz		() mages	
H-Blank [Pixel]	11: 2880x480 @ 60 H: 11: 2880x480 @ 59 9/	LI-			
Lines per Fram	e 12:2880x240p @ 60.1	15 Hz		Remove	
Line Length [B	13: 2880x240p @ 59.8 ts 14: 1440x480p @ 60 H	86 Hz z		File	Resolution
Pixel Clock	14: 1440x480p @ 59.9 15: 1440x480p @ 60 H	4 Hz		Filename	Resolution
ParBERT Freq	Je 15: 1440x480p @ 59.9	4 Hz			
ParBERT Bt C	16: 1920x1080p @ 59.	94 Hz			
ParBERT Men	or 17: 720x576p @ 50 Hz 18: 720x576p @ 50 Hz		8		
ParBERT Merr	ory Usage	44,880,000	Bt		
Valid for ParBE	RT	False	-		

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

М	1 to M2 = -1.319865 u	s								
	Sample Number	СНО	CH1		V	Н	VGB	VDP	DI	Time
	8364	CTLO	CTL1	CTLO	0	0	Ο	0	0	56.323232 us
	8365	CTLO	CTL1	CTLO						56.329966 us
	8366	CTLO	CTL1	CTLO						56.336700 us
	8367	CTL3	CTL1	CTLO						56.343434 us
	8368	CTL3	CTL1	CTLO						56.350168 us
	8369	CTL3	CTL1	CTLO						56.356902 us
	8370	CTL3	CTL1	CTL1						56.363636 us
	8371	CTL3	CTL1	CTL1						56.370370 us
	8372	CTL3	CTL1	CTL1						56.377104 us
	8373	CTL3	CTL1	CTL1						56.383838 us
	8374	CTL3	CTL1	CTL1						56.390572 us
	8375	CTL3	CTL1	CTL1						56.397306 us
	8376	CTL3	CTL1	CTL1						56.404040 us
	8377	CTL3	CTL1	CTL1	0	0	0	0	0	56.410774 us
12 +	8378	TERC4 F	Data Isla	Data Isl						56.417508 us
	8379	TERC4_F	Data Isla.	Data Isl						56.424242 us
	8380	TERC4_7	TERC4_0	TERC4_0						56.430976 us
	8381	TERC4_F	TERC4_0	TERC4_0						56.437710 us
	8382	TERC4_B	TERC4_0	TERC4_0						56.444444 us
	8383	TERC4_B	TERC4_0	TERC4_0						56.451178 us
	8384	TERC4_B	TERC4_0	TERC4_0						56.457912 us
	8385	TERC4_B	TERC4_0	TERC4_0						56.464646 us
	8386	TERC4_B	TERC4_0	TERC4_0						56.471380 us
	8387	TERC4_B	TERC4_0	TERC4_0						56.478114 us
	8388	TERC4_B	TERC4_0	TERC4_0						56.484848 us
		TERC4_B	TERC4_0	TERC4_0						56.491582 us
		TERC4_B	TERC4_0	TERC4_0						56.498316 us

Figure 8.

Supported CTS tests

Table 1. Supported HDMI CTS 1.4 sink and source tests

		N5998A	E4887A TMDS	Quantum
Test	Name	PAG	Signal Generator	Data 882CA
Source protocol				
7-16	Legal Codes	Х		
7-17	Basic Protocol	Х		
7-18	Extended Control Period	Х		
7-19	Packet Types	Х		
Source video				
7-23	Pixel Encoding – RGB to RGB Sink	Х		
7-24	Pixel Encoding – YCbCr to YCbCr Sink	Х		
7-25	Video Format Timing	Х		
7-26	Pixel Repetition	Х		
7-27	AVI InfoFrame	Х		
Source audio				
7-28	IEC 60958/IEC 61937	Х		
7-29	ACR	Х		
7-30	Audio Sample Packet Jitter	Х		
7-31	Audio InfoFrame	Х		
7-32	Audio Sample Packet Layout	Х		
Source interoperab	ility with DVI			
7-33	Interoperability with DVI	Х		
Source advanced f	eatures			
7-34	Deep Color	Х		
7-35	Gamut Metadata Transmission	Х		
7-36	High Bitrate Audio	Х		
7-37	One Bit Audio	Х		
7-38	3D Video Format Timing	Х		
7-40	Extended Colorimetry Transmission	Х		
Sink electrical				
8-5	TMDS – Min/Max Diff. Swing Tol.		Х	
8-6	TMDS – Intra-Pair Skew		Х	
8-7	TMDS – Jitter Tolerance		Х	
Sink protocol				
8-15	Char. Synchronization		Х	
8-16	Accep. of All Valid Packet Types	Х		
Sink video				
8-17	Basic Format Support Req.			Х
8-18	HDMI Format Support Req.			Х
8-19	Pixel Encoding Requirements		Х	Х
8-20	Video Format Timing		Х	
Sink audio				
8-21	Audio Clock Regeneration	Х		
8-22	Audio Sample Packet Jitter		Х	
8-23	Audio Formats	Х		
Sink interoperabilit	y with DVI			
8-24	Interoperability with DVI		Х	
Sink advanced feat	ures			
8-25	Deep Color	Х	Х	
8-29	3D Video Format Timing	Х		
8-30	4K x 2K Video Format Timing		Х	
8-31	AVI Info Frame supporting extended colorimetry,	Х		
	content type, selectable YCC Quantization Range			

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

Supported video formats

Table 2.													
CEA		Picture	Picture Analyzer				Generator						
video			aspect	24	30	36	48		24	30	36	48	
ID code	Format	Field rate	ratio	bit	bit	bit	bit	3D	bit	bit	bit	bit	3D
1	640x480p	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
2	720x480p	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
3	720x480p	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
4	1280x720p	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	Х
5	1920x1080i	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
6	720(1440)×480i	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
7	720(1440)×480i	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
8	720(1440)x240p	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	В	В	Т	
9	720(1440)x240p	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	В	В	Т	
10	2880x480i	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	В	В	Т	
11	2880x480i	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	В	В	Т	
12	2880x240p	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	В	В	Т	
13	2880x240p	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	В	В	Т	
14	1440x480p	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
15	1440x480p	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
16	1920x1080p	59.94 Hz/60 Hz	16:9	Х	Х	Х			Х	Х	Х	Т	
17	720x576p	50 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
18	720x576p	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
19	1280x720p	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	Х
20	1920x1080i	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
21	720(1440)×576i	50 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
22	720(1440)x576i	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
23	720(1440)x288p	50 Hz	4:3	Х	Х	Х	Х	Х	В	Т	Т	Т	
24	720(1440)x288p	50 Hz	16:9	Х	Х	Х	Х	Х	В	Т	Т	Т	
25	2880x576i	50 Hz	4:3	Х	Х	Х	Х	Х	Х	Т	Т	Т	
26	2880x576i	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Т	Т	Т	
27	2880x288p	50 Hz	4:3	Х	Х	Х	Х	Х	Х	Т	Т	Т	
28	2880x288p	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Т	Т	Т	
29	1440x576p	50 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
30	1440x576p	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
31	1920x1080p	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
32	1920x1080p	23.97 Hz/24 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	Х
33	1920x1080p	25 Hz	16:9	Х	Х	Х	Х	Х	Х	Т	Т	Т	
34	1920x1080p	29.97 Hz/30 Hz	16:9	Х	Х	Х	Х	Х	Х	Т	Т	Т	
35	2880x480p	59.94 Hz/60 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
36	2880x480p	59.94 Hz/60 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
37	2880x576p	50 Hz	4:3	Х	Х	Х	Х	Х	Х	Х	Х	Т	
38	2880x576p	50 Hz	16:9	Х	Х	Х	Х	Х	Х	Х	Х	Т	
39	1920x1080i	50 Hz	16:9	Х	Х	Х	Х	Х	В	Т	Т	Т	
40	1920x1080i	100 Hz	16:9	Х	Х	Х			В	Т	Т	Т	
41	1280x720p	100 Hz	16:9	Х	Х	Х			В		Т	Т	

Supported video formats (continued)

Table 2.													
CEA			Picture		Δ	nalyz	er			G	enera	tor	
video			aspect	24	30	36	48		24	30	36	48	
ID code	Format	Field rate	ratio	bit	bit	bit	bit	3D	bit	bit	bit	bit	3D
42	720x576p	100 Hz	4:3	Х	Х	Х	Х	Х	В	Т	Т	Т	
43	720x576p	100 Hz	16:9	Х	Х	Х	Х	Х	В	Т	Т	Т	
44	720(1440)x576i	100 Hz	4:3	Х	Х	Х	Х	Х	В	Т	Т	Т	
45	720(1440)x576i	100 Hz	16:9	Х	Х	Х	Х	Х	В	Т	Т	Т	
46	1920x1080i	119.88 Hz/120 Hz	16:9	Х	Х	Х			В		Т	Т	
47	1280x720p	119.88 Hz/120 Hz	16:9	Х	Х	Х			В			Т	
48	720x480p	119.88 Hz/120 Hz	4:3	Х	Х	Х	Х	Х	В			Т	
49	720x480p	119.88 Hz/120 Hz	16:9	Х	Х	Х	Х	Х	В			Т	
50	720(1440)x480i	119.88 Hz/120 Hz	4:3	Х	Х	Х	Х	Х	В	Т	Т	Т	
51	720(1440)x480i	119.88 Hz/120 Hz	16:9	Х	Х	Х	Х	Х	В	Т	Т	Т	
52	720x576p	200 Hz	4:3	Х	Х	Х	Х	Х	В	Т	Т	Т	
53	720x576p	200 Hz	16:9	Х	Х	Х	Х	Х	В	Т	Т	Т	
54	720(1440)x576i	200 Hz	4:3	Х	Х	Х	Х	Х	В	Т	Т	Т	
55	720(1440)x576i	200 Hz	16:9	Х	Х	Х	Х	Х	В	Т	Т	Т	
56	720x480p	239.76 Hz/240 Hz	4:3	Х	Х	Х	Х	Х	В			Т	
57	720x480p	239.76 Hz/240 Hz	16:9	Х	Х	Х	Х	Х	В			Т	
58	720(1440)x480i	239.76 Hz/240 Hz	4:3	Х	Х	Х	Х	Х	В			Т	
59	720(1440)x480i	239.76 Hz/240 Hz	16:9	Х	Х	Х	Х	Х	В			Т	
60	1280x720p	24 Hz		Х	Х	Х	Х	Х	Х				
61	1280x720p	25 Hz		Х	Х	Х	Х	Х	Х				
62	1280x720p	29.7 Hz/30 Hz		Х	Х	Х	Х	Х	Х				
63	1920x1080p	120 Hz		Х	Х	Х	Х	Х	Т				
63	1920x1080p	100 Hz		Х	Х	Х	Х	Х	Т				

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
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 Agilent Literature

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

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