

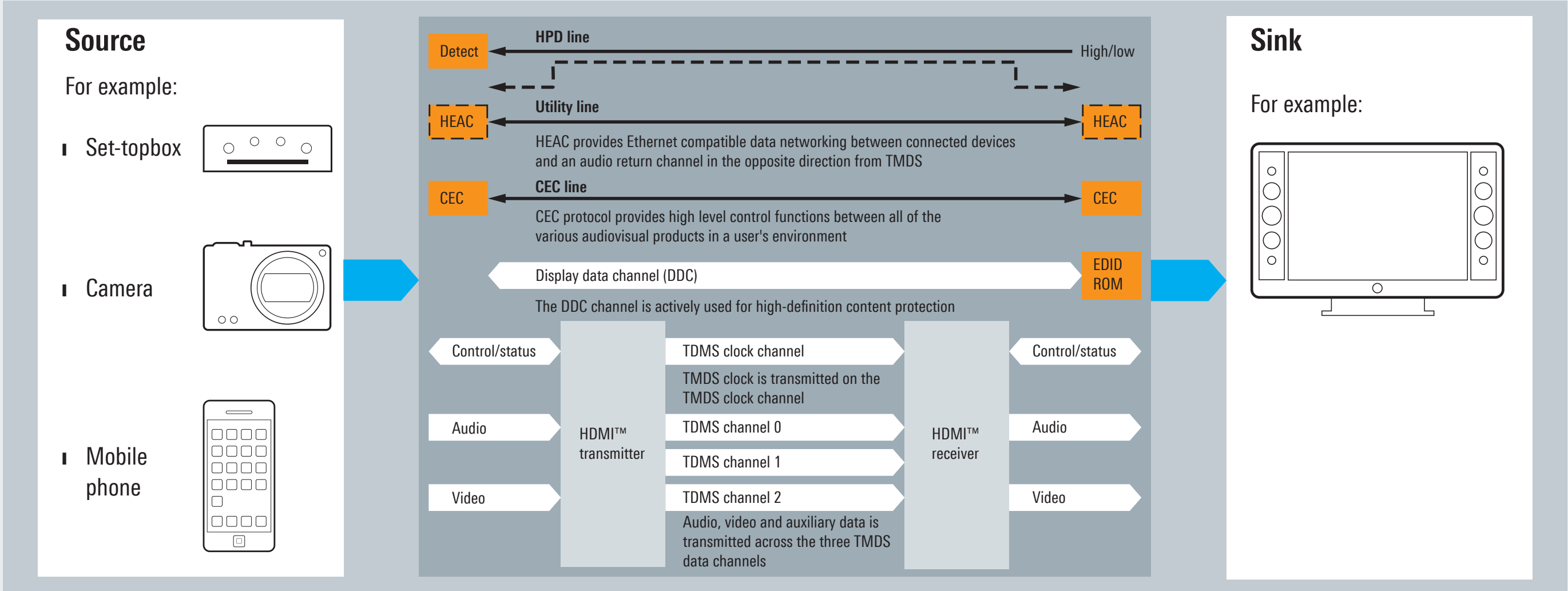
HDMI™

(high-definition multimedia interface)

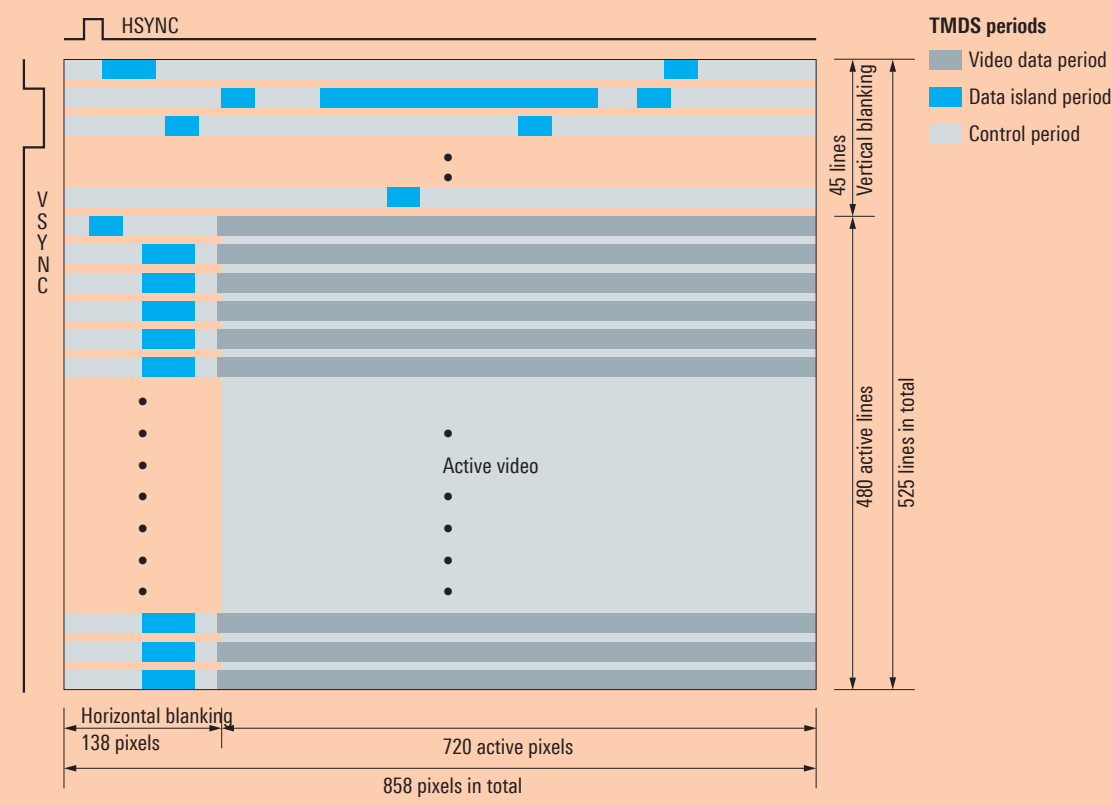
High-definition multimedia interface (HDMI™) is an interface for transmitting audio and video data between consumer electronics devices. Since its introduction in 2001, it has become the official successor of the analog interfaces in the consumer domain. Since then, HDMI™ LLC and HDMI™ Forum have continuously improved the specifications to include new market requirements and higher resolutions.

- Advantages of HDMI™:**
- Most common A/V interface with support from more than 3 billion devices
 - Uncompressed video with up to 4k resolution
 - Eight-channel uncompressed PCM or compressed audio
 - High-bandwidth digital content protection (HDCP) to ensure the copyright of transmitted media content

- Consumer electronics control (CEC) for control between interconnected devices
- Ethernet channel (HEC) tunnels IP connections between interconnected devices
- Audio return channel (ARC) replaces additional S/PDIF audio wiring
- Downward-compatible with DVI and previous HDMI™ versions

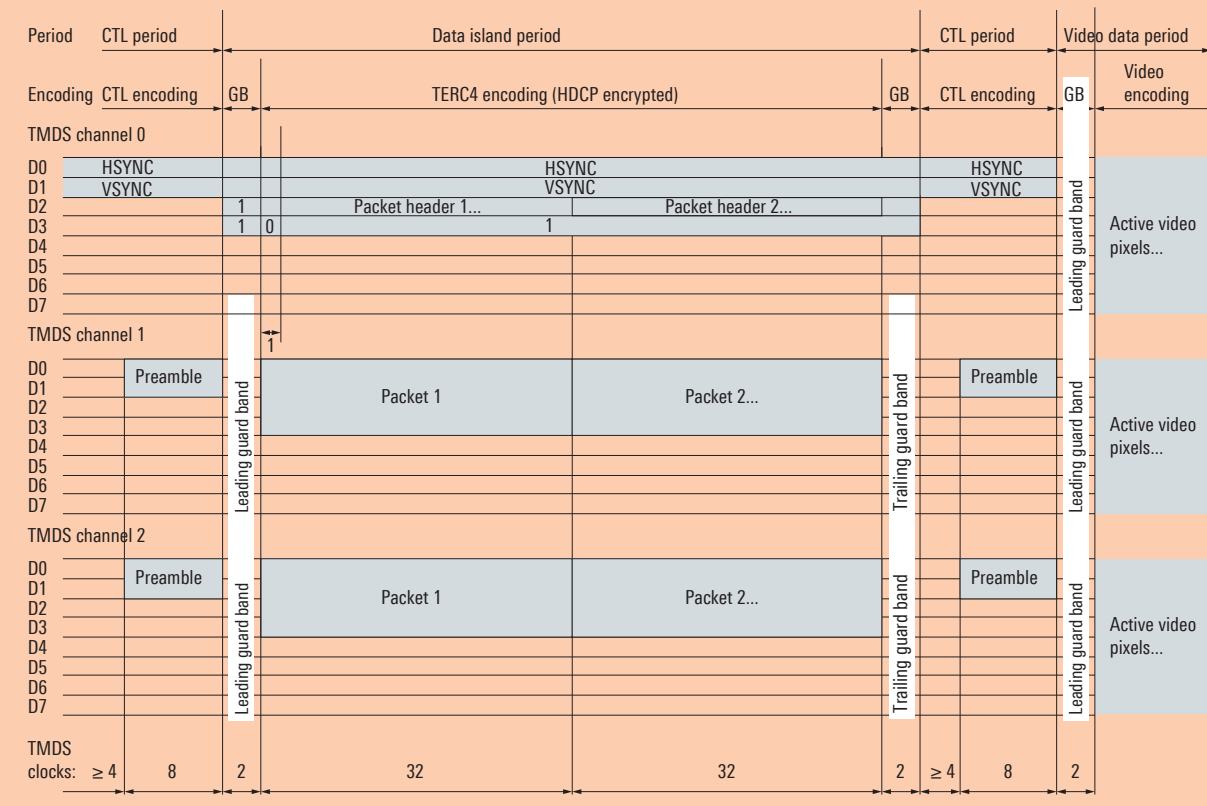


TMDS



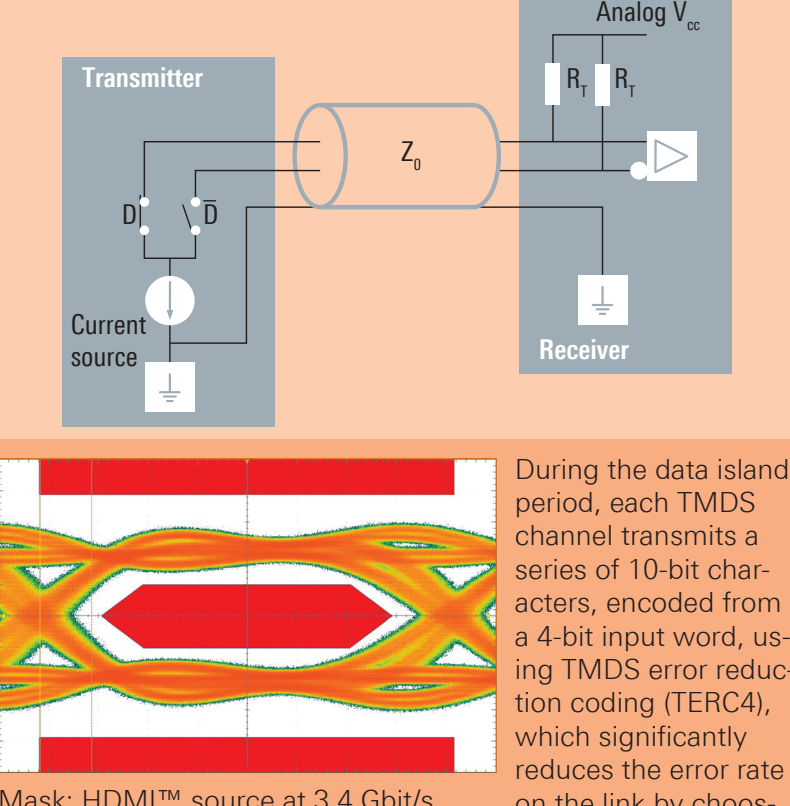
HDMI™ supports nearly all known resolutions for CE instruments such as TV sets or PCs as well as higher resolutions such as 1440p and 4k and 3D up to 1080p.

Data island overview



Excerpt of commonly used video codes, resolutions and pixel clocks (for detailed timing see CEA-861-D or later version of CEA-861)		
Video code	Resolution	Pixel clock
Standard television SDTV CEA-861 video code		
2.3	640×480 (VGA), 59.94/60 Hz	25.175 MHz
12.18	720×480p, 59.94/60 Hz	27.000 MHz
6.7	720×576p, 50 Hz	27.000 MHz
21.22	720 (1140)×480, 59.94/60 Hz	27.000 MHz
	720 (1140)×576i, 50 Hz	27.000 MHz
High-definition television HDTV CEA-861 video code		
4	1280×720p, 59.94/60 Hz	74.250 MHz
19	1280×720p, 50 Hz	74.250 MHz
5	1920×1080i, 59.94/60 Hz	74.250 MHz
20	1920×1080i, 50 Hz	74.250 MHz
16	1920×1080p, 59.94/60 Hz	148.500 MHz
31	1920×1080p, 50 Hz	148.500 MHz
34	1920×1080p, 29.97/30 Hz	74.250 MHz
Ultra high-definition television UHD TV(4k) HDMI™ video code		
0x01	3840×2160p, 29.97/30 Hz	297.000 MHz
0x02	3840×2160p, 25 Hz	297.000 MHz
0x03	3840×2160p, 23.98/25 Hz	297.000 MHz
0x04	4096×2160p, 24 Hz	297.000 MHz

Physical layer of TMDS



Pixel encoding	
Y/C, 4:2:2	
Y/C, 4:4:4	
RGB 4:4:4	
Supported color spaces	
SD: ITU-R Rec. BT.601	
HD: ITU-R BT.709-5	
Additional: xvYCC, sYCC601, AdobeYCC601, AdobeRGB	
Color depths of 24 (3×8), 30 (3×10), 36 (3×12) and/or 48 (3×16) bit per pixel	
Audio formats	
Uncompressed audio:	8-channel PCM with sample rate of 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz or 192 kHz
Compressed audio:	(IEC 61937) Dolby Digital (Plus), DTS (+HD), MPEG, one bit audio (DVD audio, SACD) with a maximum bit rate of 6.144 Mbps (frame rate of 192 kHz)
Primary 3D video modes	
1280×720p, 50/59.94/60 Hz (frame packing, side-by-side (half), top-and-bottom)	
1280×720p, 23.98/24/29.97/30 Hz (frame packing)	
1920×1080i, 50/59.94/60 Hz (frame packing, side-by-side (half))	
1920×1080p, 23.98/24 Hz (frame packing, side-by-side (half), top-and-bottom)	
1920×1080p, 29.97/30 Hz (frame packing, top-and-bottom)	
1920×1080p, 50/59.94/60 Hz (top-and-bottom)	

Connectors and pin assignment

HDMI™ connector types



Standard (type A): typically used in TV sets



Micro (type D): typically used in mobile phones



Mini (type C): typically used in cameras



Automotive connection system (type E): for internal connections

Pin assignment of HDMI™ connectors (type A and E)

Signal	Type A	Type E	Signal	Signal	Type A	Type E	Signal
TMDS data2+	pin 1	pin 1	TMDS data5+	TMDS clock shield	pin 11	pin 11	
TMDS data2- shield	pin 2	pin 2	TMDS data5- shield	TMDS clock-	pin 12	pin 12	
TMDS data1+	pin 3	pin 3	TMDS data4+	CEC	pin 13	pin 13	
TMDS data1- shield	pin 4	pin 4	TMDS data4- shield	Reserved (HDMI™ 1.0 to 1.3); HEC Data- (HDMI™ 1.4)	pin 14	pin 14	reserved
TMDS data0+	pin 5	pin 5	TMDS data3+	SCL (I²C serial clock for DDC)	pin 15	pin 15	SCL (DDC clock)
TMDS data0- shield	pin 6	pin 6	TMDS data3- shield	SDA (I²C serial data line for DDC)	pin 16	pin 16	SDA (DDC data)
TMDS data0+	pin 7	pin 7	TMDS data3+	DDC/CEC/HEC ground	pin 17	pin 17	DDC/CEC ground
TMDS data0- shield	pin 8	pin 8	TMDS data3- shield	+5 V supply voltage (max. 55 mA)	pin 18	pin 18	+5 V (power EDID/DDC)
TMDS data0+	pin 9	pin 9	TMDS data3+	Hot plug recognition (all versions), HEC Data+ (HDMI™ 1.4)	pin 19	pin 19	hot plug detect
TMDS data0- shield	pin 10	pin 10	CEC	Marketing name (from Adopted Trademark and Logo Usage Guidelines)	standard	automotive	
TMDS clock+							

Selection of Rohde & Schwarz solutions for HDMI™



R&S UPP audio analyzer



R&S VTS compact video tester



R&S VTE video tester



R&S VTC video test center

Glossary:
HDMI = High-definition multimedia interface; **AV** = Audio/video;
PCM = Pulse code modulation; **HDCP** = High-bandwidth digital content protection; **CEC** = Consumer electronics control; **HEC** = HDMI Ethernet channel; **ARC** = Audio return channel; **S/PDIF** = Sony/Philips digital interconnect format; **DVI** = Digital visual interface; **HPD** = Hot plug detection; **HEAC** = HDMI Ethernet and audio return channel; **TMDS** = Transition minimized differential signaling; **DDC** = Display data channel; **EDID** = Extended display identification data; **CTL** = Control; **TERC** = TMDS error reduction coding; **HSYNC** = Horizontal synchronization; **VS** = Vertical synchronization; **CE** = Consumer electronics; **SDTV** = Standard definition television; **HDTV** = High-definition television; **UHD TV** = Ultra high-definition television; **Y,C,C** = Luma (Y), chroma (C_u, C_v) components; **RGB** = Red(R), green(G), blue(B) components; **SD** = Standard definition; **HD** = High-definition; **IEC** = International Electrotechnical Commission; **MPEG** = Moving Picture Experts Group; **SACD** = Super audio compact disc; **SCL** = Serial clock; **SDA** = Serial data

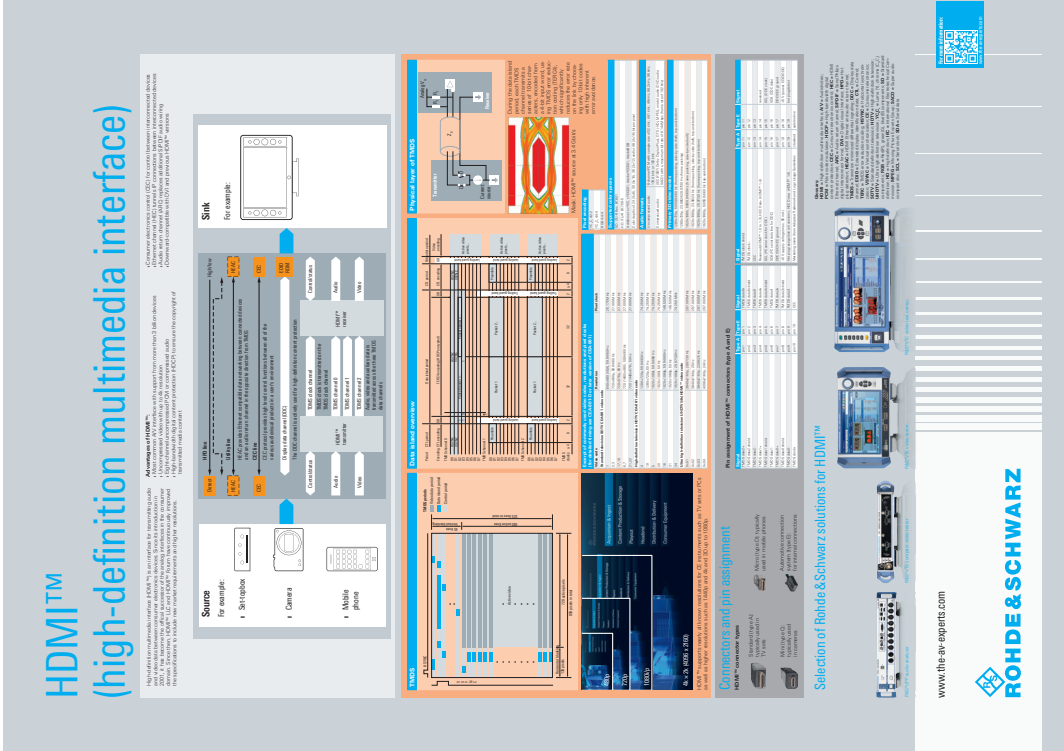
www.the-av-experts.com



For more information:



www.the-av-experts.com



HDMI™ (high-definition multimedia interface)

About Rohde & Schwarz

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radio monitoring and telecommunication, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system



Rohde & Schwarz GmbH & Co. KG

www.rts.rsg.rohde-schwarz.com

Regional contact

- Europe, Africa, Middle East | +49 89 4129 12345
customersupport@rohde-schwarz.com
- North America | 888 TEST NSA (1 888 837 87 72)
customersupportna@rohde-schwarz.com
- Latin America | +1 410 910 79 88
customersupportlat@rohde-schwarz.com
- Asia/Pacific | +65 65 13 04 88
customersupportasia@rohde-schwarz.com
- China | +86 800 810 8228 / +86 400 690 9696
customersupportchina@rohde-schwarz.com

Service you can rely on

- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependency



080610002