Instrument overview R&S VTC , VTE, VTS: media interface analyzer family

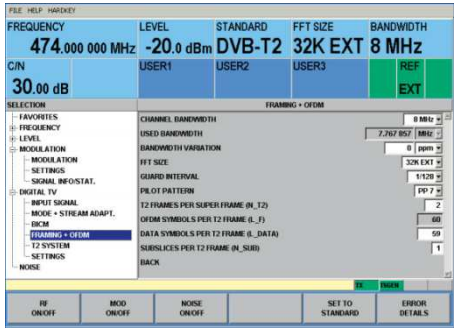
- Universal measurement platform for
  - HDMI 1.4/2.0a
  - MHL 1.4/2.2
  - Analog A/V
- Protocol compliance testing
- Audio and video analysis up to 4K / UHD
- Electrical TMDS analysis
- Broadcast signal generation for DUT stimulation
- Test automation and report generation

Instrument comparison

	R&S VTC	R&S VTE	R&S VTS
Picture			
Name	Video Test Center	Video Tester	Compact Video Tester
Height	4 HU	3 HU	1 HU
Width	19”	19” / 2	19” / 2
Display	11,6” 1366 x 768 16:9	7” 800 x 480 5:3	DVI connector (no integrated display)
Module slots	8	3	1

Modular concept

Base units



Broadcast modulator options

AV interface modules / options

AV analysis options

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AV interface testing

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HDMI interface testing

Overview

- Universal HDMI testing module offering all required interfaces:
  - HDMI IN — HDMI signal analysis up to 18 GBit/s
  - HDMI OUT — HDMI signal generation up to 18 GBit/s and HDMI audio input for ARC testing
  - S/PDIF IN — Audio analysis and signal routing to HDMI IN (ARC)
- Signal generation and analysis
  - is in line with HDMI 2.0a (covering CEA-861F and VESA standards)
  - supports HDCP 1.4 and 2.2
  - covers video signals up to 4K / UHD resolution (60Hz progressive, 4:4:4)
- Functions are enabled by options (next slides)

R&S VT-B2363 HDMI RX/TX 600 MHz module

HDMI interface testing

Signal analysis - VT-K2364 HDMI RX (I)

- Hot plug detection (HPD)
  - HDP on / off setting
  - 5V power status display
- HDCP 1.4 / 2.2 de-cryption
  - On / off setting and status display
  - Reconnection request (re-authentication)
- EDID simulation with example EDIDs (see also EDID editing)
- Extensive audio and video content analysis (see AV analysis)
- Audio video output

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HDMI interface testing

Signal analysis - VT-K2364 HDMI RX (II)

- Display of relevant protocol parameters:
  - Video timing parameters
  - Audio parameters
  - Status and Control Data Channel (SCDC) status
- InfoFrame analysis:
  - Auxiliary video InfoFrame (AVI),
  - Audio InfoFrame,
  - HDMI Vendor Specific InfoFrame (H14b VSIF),
  - HDMI Forum Vendor Specific InfoFrame (HF-VSIF),
  - Dynamic Range and Mastering InfoFrame (DRM),
  - Source Product Description (SPD)
  - MPEG InfoFrame

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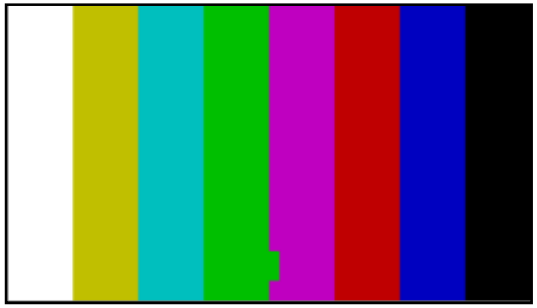
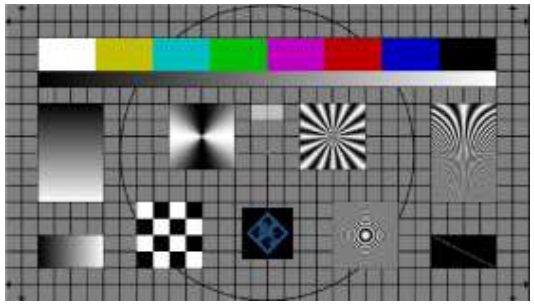
HDMI interface testing

Signal generation - VT-K364 HDMI TX (I)

- Standard compliant, reliable, reproducible, error free signal generation
- Static pattern generation
  - extensive pattern library including the signals: chess board, Pluge, noise, colors, multiburst, 3D cross talk, 3D contrast and SMPTE
  - all CEA-861F (VIC1 – 107) and VESA video formats up to 4K resolution
- Configurable pixel shift and line shift function
  to generate moving content based on static patterns
- 8 channel PCM sine tone generator with definable
  - sine tone frequency
  - sampling rate
  - audio level
  - resolution

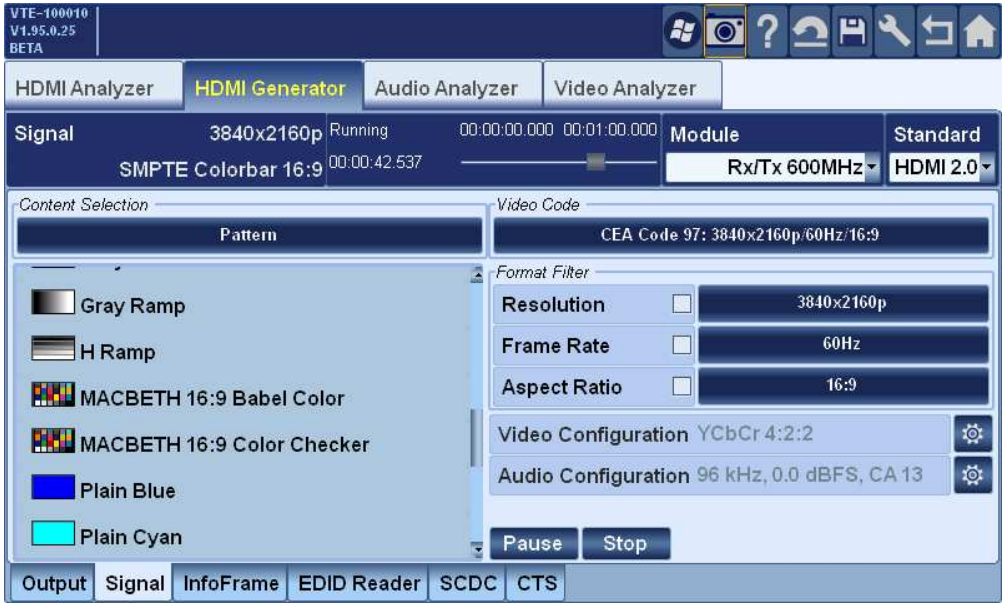




HDMI interface testing

Signal generation - VT-K364 HDMI TX (II)

- Hot plug detection (HPD)
  - 5V on / off setting
  - Sink HPD status display
- HDCP 1.4 / 2.2 encryption
  - On / off setting and status display
  - Reconnection request (re-authentication)
- Display and save of sink's EDID data
- Status and Control Data Channel (SCDC) status display



HDMI interface testing
Signal generation - VT-K364 HDMI TX (III)

- Configurable video amplitude
- Definable parameters like
  - pixel encoding
  - DVI mode
  - 3D mode
  - level and bit depth
- Generation of nonstandard signals for stress testing (R&S®VT-K362 HDMI TX user defined timing)
  - timing adjustment
  - InfoFrame adaptation (also supporting HDR meta data signaling)
- Audio analysis for ARC signals received via HDMI out connector (with audio analysis option (see Audio analysis))

HDMI interface testing

Signal generation - VT-K361 HDMI moving pictures

Uncompressed moving picture playout

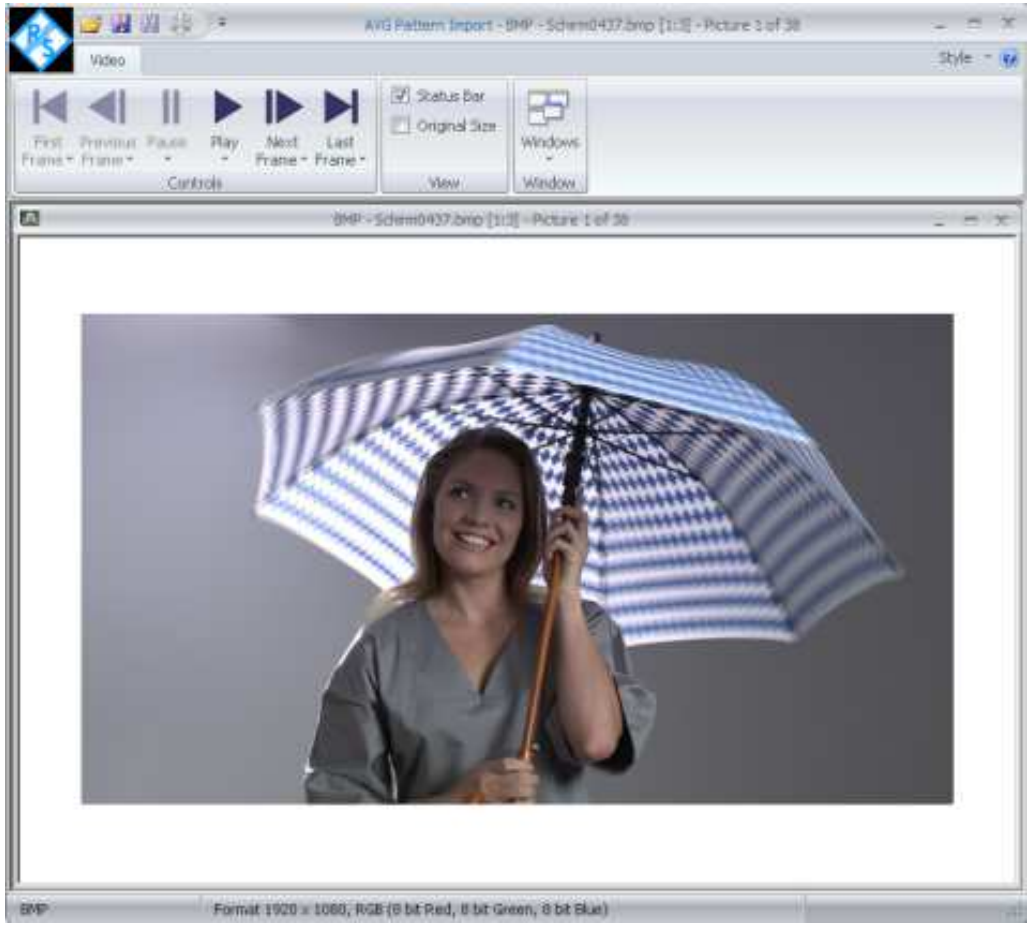
- up to 8 Gbyte of uncompressed video / audio data
  (~ 13 seconds FullHD content (1080p, 4:4:4, 12Bit/pixel, 60Hz)
  ~ 4 seconds UHD content (4kx2k, 4:4:4, 8Bit/pixel, 60Hz))
- several test sequences like "Lip-sync"
  "Moving color bar (EMC)"
  and moving text

HDMI interface testing

Signal generation – AV data import

User defined test patterns
and sequences
(AVG Pattern Import software)

- Video data import
  (BMP, TIFF or YUV16)
- PCM audio import
  (up to 8 channels,
  WAV file based)



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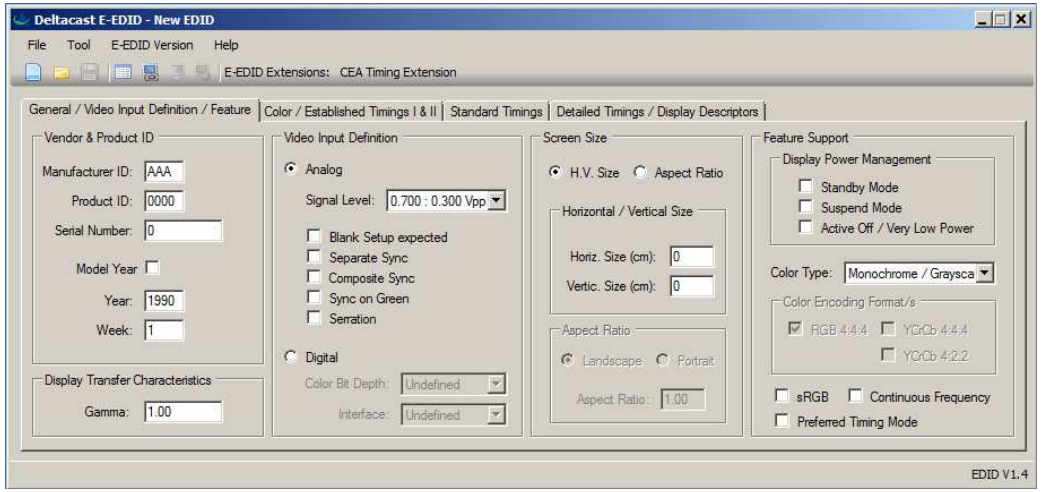
HDMI interface testing

EDID editing

- EDIDs of sink devices can be displayed and stored on hard disk using the HDMI/MHL generator application
- EDIDs stored on hard disk can be used by the HDMI/MHL analyzer application
- Editing of EDIDs is supported by third party SW
- Example: E-EDID Editor from Deltacast
  (Free download: http://www.deltacast.tv/products/free-software/e-edid-editor)
  - Representation of the EDID data in text fields and in a Hexadecimal Viewer
  - EDID V1.3 and V1.4 support with switching to each other
  - CEA Timing Extension support



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HDMI interface testing

DDC / CEC analysis - VT-K2391 CEC/DDC analyzer (I)

Testing of sinks and sources:

- Send, receive, log and interpret CEC commands;
- Quick Mode: send one of the most common CEC commands or one of up to 20 user defined CEC commands to the DUT by just one “click”
- Vary bit timing and disable acknowledgments for CEC stress testing

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HDMI interface testing

DDC / CEC analysis - VT-K2391 CEC/DDC analyzer (II)

Testing of sinks and sources:

- Log DDC communication and display selected packets in detail including an interpreter for HDCP 1.4/2.2 packets
- As source: read and write SCDC registers
  (as sink: SCDS registers are maintained by VT-K2364 HDMI RX automatically)
- As source: read EDID and display interpreted content
  (as sink: standard or by user defined / selected EDID can be loaded)

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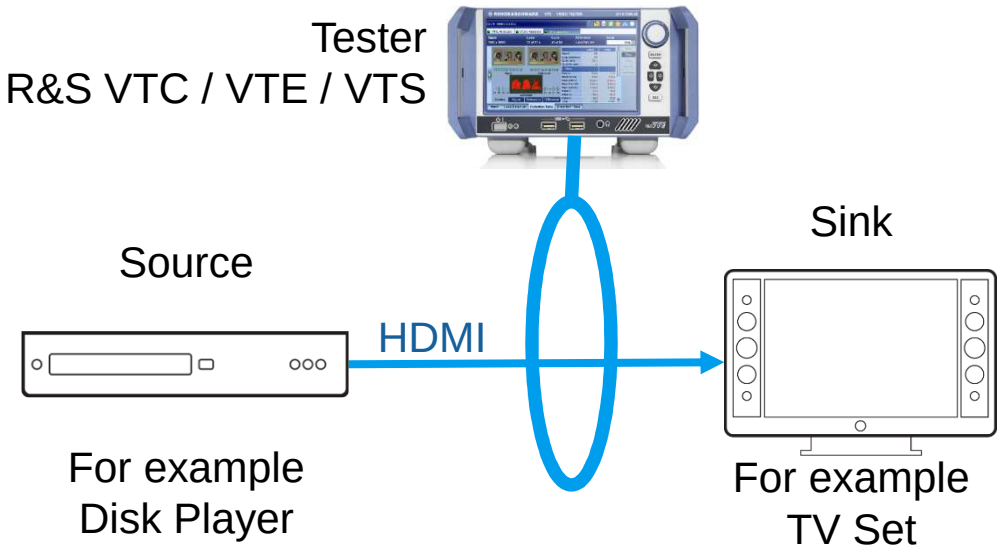
HDMI interface testing

DDC / CEC analysis - VT-K2391 CEC/DDC analyzer (III)

Testing of communication between sink and source (passive):
(2 DUTs, requires VT-Z2390 HDMI pass-through adapter):

- Snoop and interpret CEC commands
- In addition act as active CEC device as described under sink and source testing
- Snoop DDC communication and display selected packets in detail
- Interpret HDCP 1.4/2.2 packets



HDMI interface testing

CTS testing – Supported tests

- HDMI 1.4 and 2.0 testing in accordance to the HDMI Compliance Test Specification (CTS)
- R&S is an active member of the HDMI forum adding and approving new CTS Test IDs continuously.

- Several tests from the given categories are supported and approved:
  - R&S VT-K2367 HDMI 1.4 CTS source test

    7.4 Protocol, 7.5 Video, 7.6 Audio, 7.7 Interoperability With DVI, 7.8 Advanced Features
  - R&S VT-K367 HDMI 1.4 CTS sink test

    8.4 Protocol, 8.5 Video, 8.6 Audio, 8.7 Interoperability With DVI, 8.8 Advanced Features
  - R&S VT-K2368 HDMI 2.0 CTS source test

    7.2 TMDS Protocol, 7.3 TMDS Pixel Encoding, 7.4 Video Timing, 7.5 Audio Encoding, 7.6 HDMI-VSIFs, 7.7 AVI InfoFrame, 7.8 Audio InfoFrame and GCP, 7.9 Audio Channel Status, 7.12 High Dynamic Range InfoFrame
  - R&S VT-K368 HDMI 2.0 CTS sink test

    8.2 TMDS Protocol, 8.3 Pixel Decoding, 8.4 Video Timing, 8.5 Audio Decoding and Rendering, 8.7 HDMI-VSIFs, 8.8 EDID
- All tests supported are listed in the VTC / VTE / VTS specification

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HDMI interface testing

CTS testing - Features

- Start of tests by a push of a button
- Optional automated testing via dedicated SW tool AVBrun
- Partial execution of tests for debugging purpose
- Clear and easy to read test results
- Test result logging
- Simple to understand (MOIs) Methods of Implementations
- TMDS raw data capture on hard disk for offline in depth analysis

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HDMI interface testing

Time domain analysis

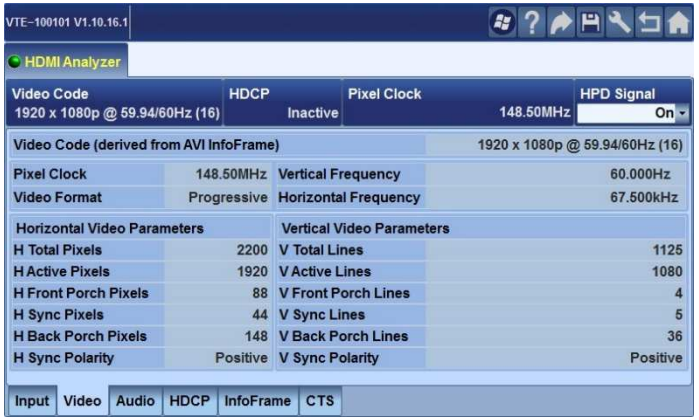
- Support of up to 6 Gbit/s (HDMI 2.0) per data line
- Integrated device emulation (EDID)
- Eye diagram display and analysis (data lines):
  - DC, rise/fall time, skew, duty cycle, frequency
- Tests for control lines (DDC / CEC)
  - DC voltage, capacity
- Clock jitter measurement
- Pre-compliance test of CTS test Ids

R&S VT-Z2385
TMDS (6 GBit/s) Time Domain Analyzer

R&S VT-B2380
HDMI RX/TX 600 MHz module

HDMI interface testing (300 MHz)

VT-B2360/B2361 HDMI RX

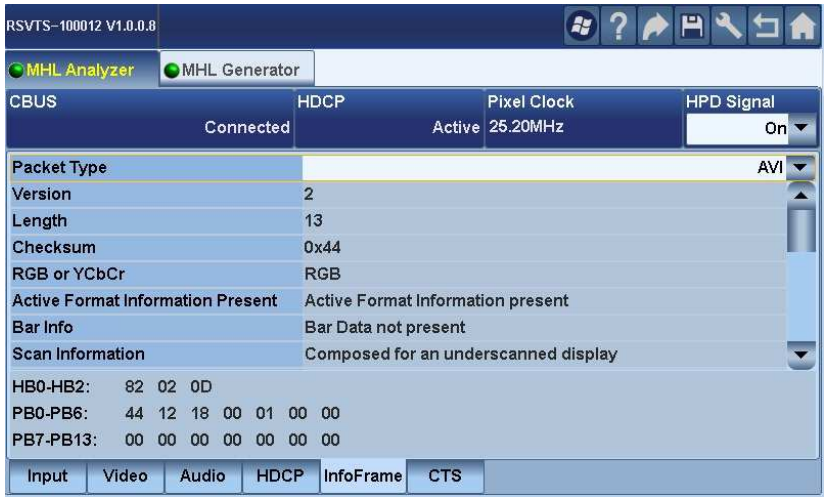


- **Module for analysis of High-Definition Multimedia Interface signals in accordance to HDMI verison 1.4/2.0**
  - VT-B2360 225 MHz for resolutions up to 1080p
  - VT-B2361 300 MHz for resolutions up to 4k x 2k
- **Features:**
  - Realtime analyzer:
    - 4:2:0 pixel coding support
    - Video / audio decoding
    - Video timings, Audio parameter
    - HDCP status
    - AVI, SPD, Audio, MPEG info frame display
  - Auxiliary HDMI output:
    - Loop out of video/audio signals from HDMI input
- **Optional:**
  - CEC tracer:
    - Send and receive CEC commands
    - Monitor CEC communication
  - HDMI protocol compliance test extensions (see next page)

MHL interface testing

Signal generation and analysis - VT-B2350 MHL RX/TX

- Mobile High-Definition Link (MHL) signal generation and analysis in accordance to MHL version 1.4 and 2.2
- Realtime analyzer for 24 bit mode:
  - Video / audio decoding
  - Video timings, Audio parameter
  - HDCP status
  - AVI, SPD, Audio, MPEG info frame display
- Realtime generator for 24 bit mode:
  - Static test pattern playout and audio PCM generator for up to 8 channels
  - EDID reader functionality
- Auxiliary HDMI output:
  - Loop out of video/audio signals from MHL input



VT-B2350 MHL RX/TX

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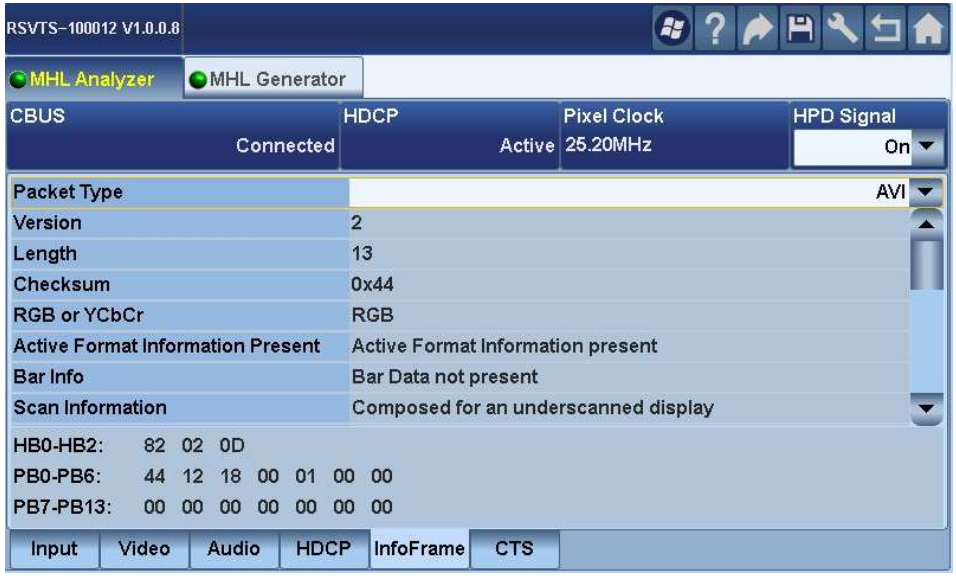
MHL interface testing

PackedPixel signal analysis - VT-B2351 MHL RX PackedPixel

- Realtime analyzer (MHL 1.4 / 2.2)
  - Video / audio decoding
  - Video timings
  - Audio parameters
  - HDCP status
  - AVI, SPD, Audio, MPEG info frame display
- Auxiliary HDMI output:
  - Loop out of video/audio signals from MHL input



VT-B2351 MHL RX PackedPixel

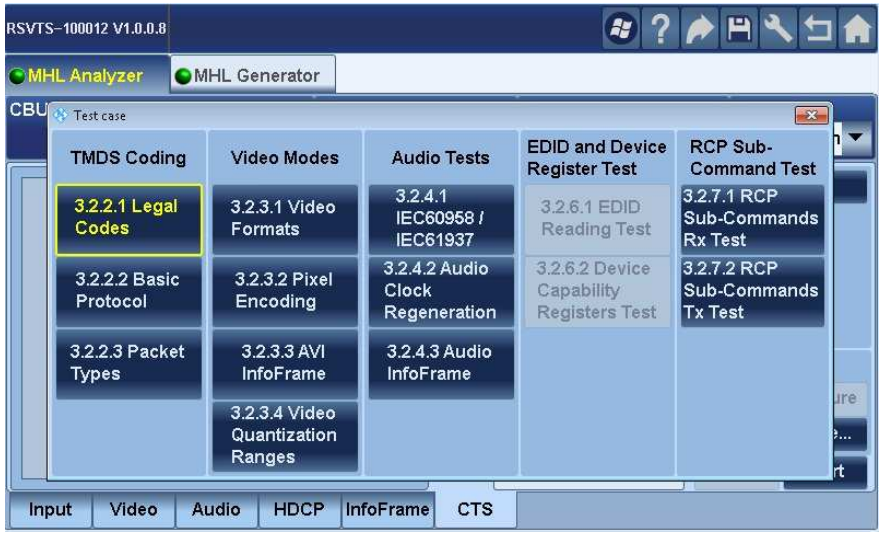
MHL interface testing
CTS testing

VT-K355 MHL CTS sink test

- Provides system tests for sink devices (e.g. TV sets) in accordance with compliance test specification

VT-K2355 MHL CTS source test

- Provides system tests for source devices (e.g. smartphones) in accordance with compliance test specification
- Modes: Instant capture and from file



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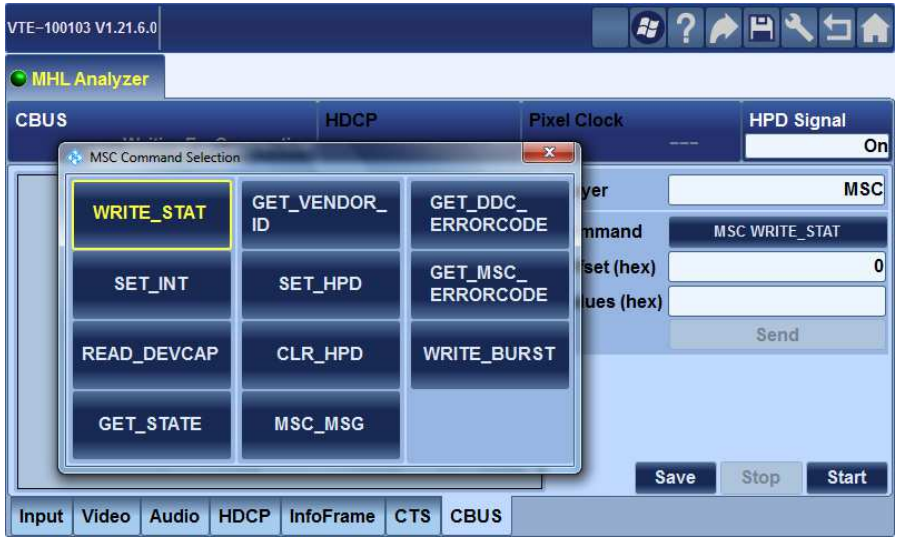
MHL interface testing

CBUS analysis - VT-K2356 CBUS Tracer

- Send, receive and trace CBUS commands
- Link layer and transition layer support.
- Traffic monitoring via list view



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Analog AV interface testing

Signal analysis - VT-B2370 Analog AV RX

- Interfaces (BNC)
  - Composite (SD resolution)
  - Component / VGA (1080p))
    requires VT-K2371 Component support
  - Unbalanced 2 channel audio
- Signal analysis requires AV analysis options (see next slides)
  - VT-K2100 Video analysis or
  - VT-K2150 Audio analysis or
  - VT-K2111 AV distortion analysis

VT-B2370 Analog AV RX

Audio Video analysis options (SW)

for all AV signals
from HDMI, MHL or analog AV interface module

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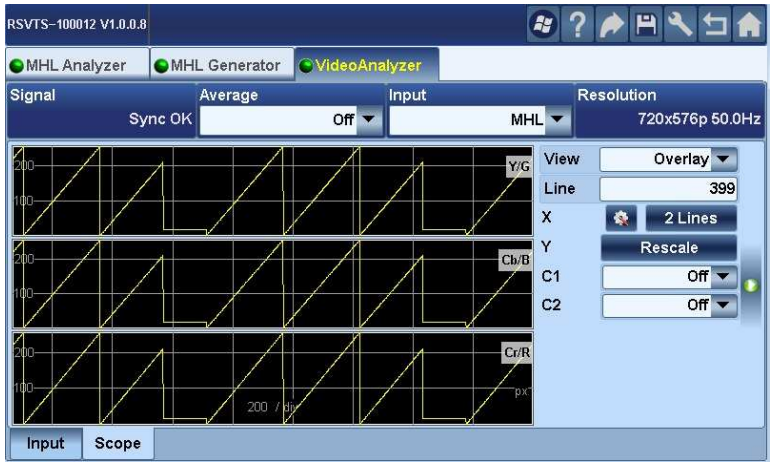
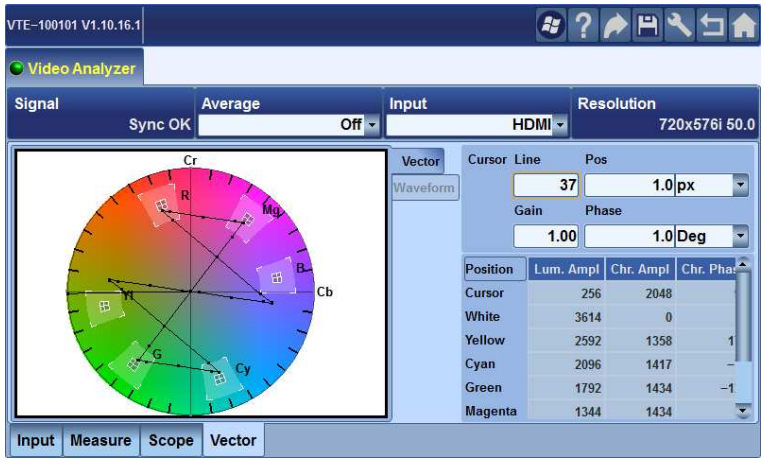
Video analysis

VT-K2100 Video analysis

- Scope function
  - Measurement of timing, level
  - Marker / ΔMarker functionality
  - Parade and overlay views for parallel assessment of component signals

- Chrominance measurement
  - Vector scope to determine the color amplitudes
  - Indication of digital color values





Video analysis

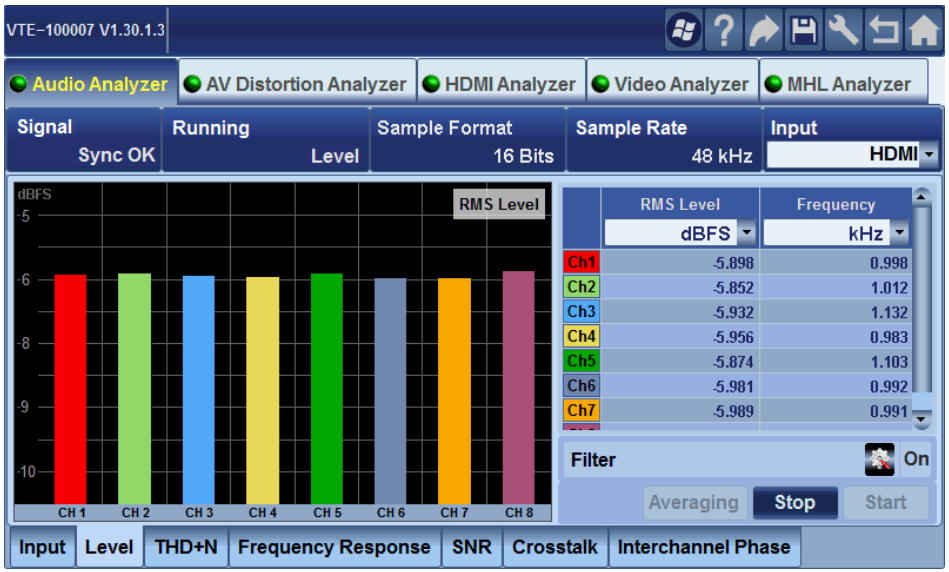
VT-K2101 Video measurements

- Automated signal parameter measurements on
  - Timing
  - Level
  - Linear and non-linear distortions
  - Noise
  - Jitter
- Supported signal types
  - Composite (SD)
  - Analog component (HD)
  - Digital component (SD / HD)

[+] All	Value	Unit	Lower Limit	Upper Limit	Status	Test Signal
[+] Amplitude and Delay					Wait...	
[–] Linear Distortions					Wait...	
Baseline Distortion	---	%	-5.0	5.0	Wait...	CCIR17 [36]
2T Pulse Amplitude	---	%	-10.0	10.0	Wait...	CCIR17 [36]
2T Pulse k-factor	---	%	-0.1	2.0	Wait...	CCIR17 [36]
2T Pulse Half Ampl Dur	---	ns	175	225	Wait...	CCIR17 [36]
2T Pulse KPB	---	%	-10.0	10.0	Wait...	CCIR17 [36]
Tilt	---	%	-10.0	10.0	Wait...	CCIR17 [36]
[+] Nonlinear Distortions					Wait...	
[+] Frequency Response					Wait...	

Audio analysis (I)

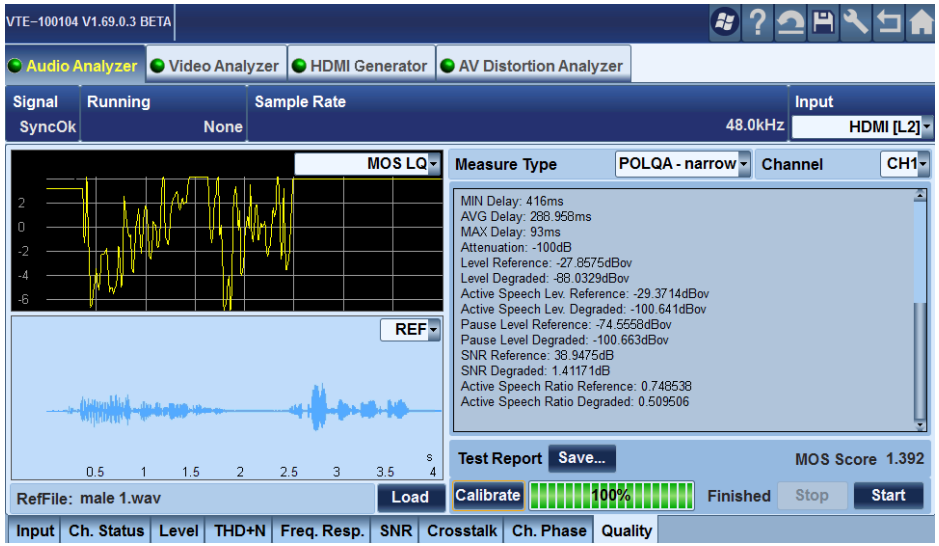
- VT-K2150 Audio analysis measurement of:
  - Level
  - THD+N
  - Frequency Response (spectrum, sweep)
  - SNR
  - Crosstalk
  - Inter-channel phase



- VT-K2151 Compressed audio support
  - Channel status bit view
  - Decoding for following standards:
    AC3, E-AC3, MPEG1 and 2, MPEG2 AAC and MPEG4 AAC

Audio analysis (II)

- VT-K2158 Speech quality measurement PESQ
  - Provides perceptual evaluation of speech quality (PESQ)
  - In line with ITU-T P.862
  - Overall / speech / noise PESQ score
  - Speech / noise MOS-LQO
  - MOS P.800/LQ
  - G.107 rating



- VT-K2159 Listening quality analysis POLQA
  - Provides perceptual objective listening quality (POLQA)
  - In line with ITU-T P.863
  - Speech POLQA score
  - MOS-LQO score
  - G.107 rating

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AV analysis

VT-K2111 AV distortion analysis

- Double ended picture quality analysis.
- Video features:
  - Difference picture display
  - PSNR, SSIM, MOS-V, pixel error, render rate, freeze, black frames, dropped frames
  - Treshold setting for visible error or picture failure point detection
- Audio features:
  - Difference audio display
  - Audio loss, audio level deviation,
- Trace view
- Logging of measurement data

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Broadcast Modulator

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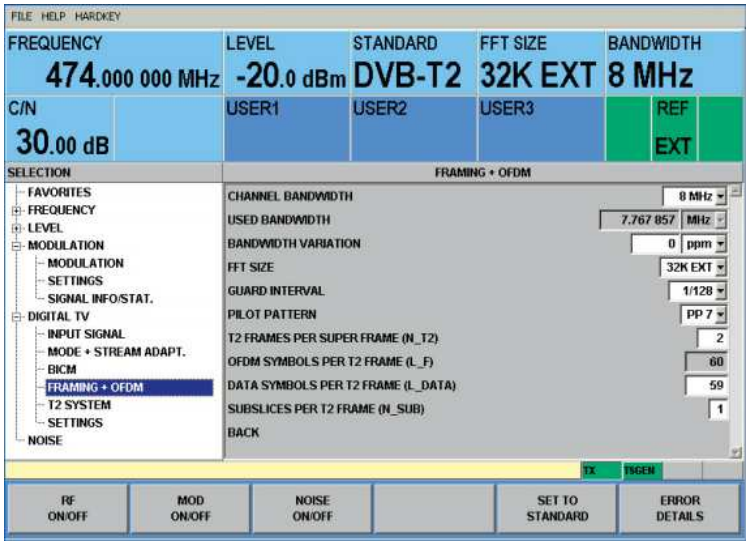
TV and audio broadcast signal generation

VT-B600 Broadcast Modulator

- Requires modulator option:
  DVB-T2, DVB-T, DTMB, ATSC/8VSB, ISDB-T, ISDB-TB, DVB-H, T-DMB, CMMB, ATSC-M/H, ISDB-T 1seg, DVB-C2, DVB-C, ISDB-C, J.83/B, DVB-S2, DVB-S/DVB-DSNG, ISDB-S, DirecTV, DMB France, DAB+, DAB, ISDB-TSB, AM, FM/RDS, B/G, D/K, I/I1, M/N, L/L'
- Integrated TS player and CCVS generator

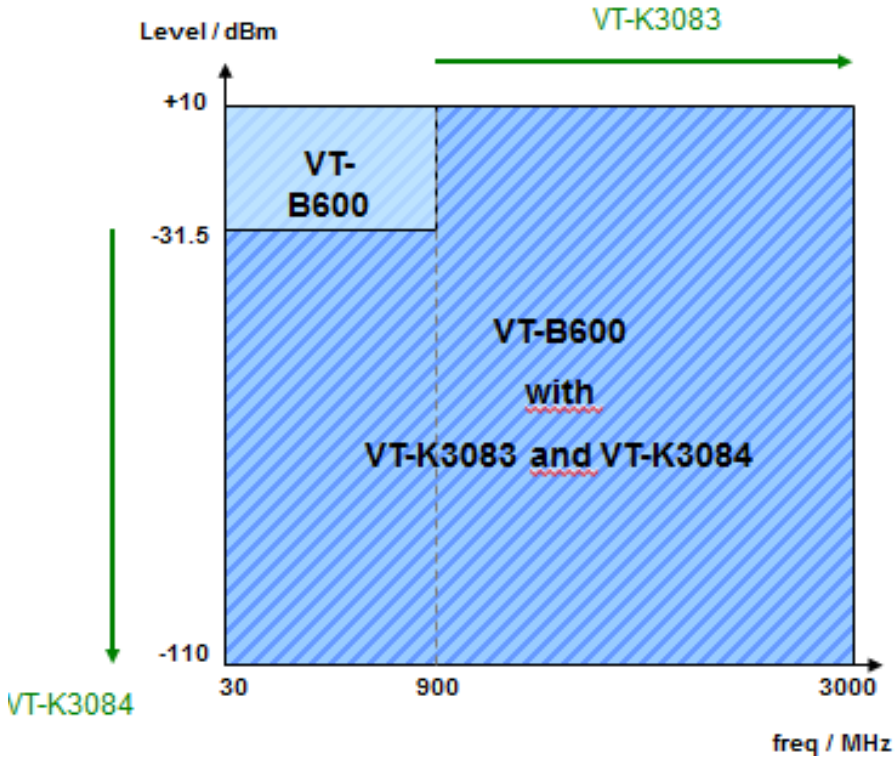


VT-B600 Broadcast Modulator

TV and audio broadcast signal generation

Additional options

- VT-K1340 AWGN generator
  - SNR configuration from -30… 60 dB
- VT-K2600 Extended I/Q Inputs
  - Activation of Digital I/Q input
- VT-K3083 Frequency extension 3 GHz
  - Base unit: 30 … 900 MHz
  - Freq. extended to: 30 … 3000 MHz
- VT-K3084 Elect. Attenuator 110 dB
  - Base unit: 10 … -31.5 dBm
  - Level attenuate to: 10 … -110 dBm



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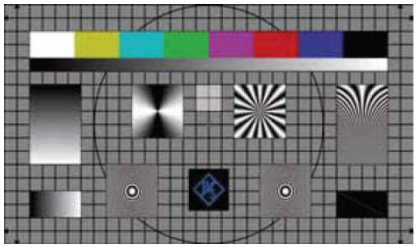
TV and audio broadcast signal generation

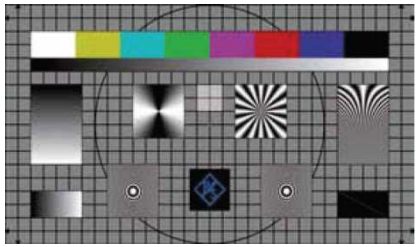
LIB-K50 – 59 transport stream libraries



Library	Type	Content
ATV-Video	LIB-K50	Test pattern library for analog TV
T-DMB/DAB streams	LIB-K51	ETI streams for DAB and T-DMB
DAB+ streams	LIB-K53	ETI streams for DAB+
ISDB-T streams	LIB-K54	ISDB-T for brazil and Argentina
CMMB streams	LIB-K55	CMMB transport streams
ATSC & Mobile DTV stre,	LIB-K56	ATSC mobile DTV (ATSC-M/H)
DVB-T2 MI streams	LIB-K57	T2-MI for DVB-T2
EMC streams	LIB-K58	Streams for EMC tests (moving color bar pattern)
DMB Streams France	LIB-K59	ETI streams for French DMB

TV and audio broadcast signal generation

LIB-K70 – 73 transport stream libraries



Library	Type	Content
Basic stream library	LIB-K70	Format: SDTV, HDTV Video: MPEG-2, H.264 Audio: MPEG-1 L2, AAC, AC-3
Extended SDTV library	LIB-K71	Format: SDTV Video: MPEG-2, H.264 Audio: MPEG-1 L2, AAC, AC-3
Extended HDTV library	LIB-K72	Format: HDTV Video: MPEG-2, H.264 Audio: MPEG-1 L2, AAC, AC-3
3D TV library	LIB-K73	Format: HDTV Video: H.264-MVC Audio: AAC

VoLTE video analysis

Downlink video quality

RF

R&S CMW500
LTE EnodeB Emulator

HDMI

R&S VTE
Video Analyzer

Video Quality Analysis

- Video (via PSNR)
- Framerate analysis
- Frozen, dropped frames
- Lip sync measurement