

# Putting audio / video interfaces through their paces



Set-top boxes, tablet PCs, smartphones – all these devices have analog or digital audio/video interfaces such as HDMI and MHL™ that have to be thoroughly tested. Two new testers now provide all the testing performance needed. Besides performing standard interface protocol tests, they analyze media content in real-time during application tests on consumer electronics equipment.

### R&S®VTE video tester – universal AV interface test platform for R&D and quality assurance

The R&S®VTE video tester (Fig. 1) is a versatile platform for testing audio and video (AV) interfaces on consumer electronics equipment in R&D and quality assurance. This highly compact, universal tester (3 HU, ½ 19") accommodates up to three test modules, which provides flexibility for future expansions and upgrades. The R&S®VTE has a capacitive 7-inch touchscreen to enable intuitive, straightforward operation. Audio signals applied to the instrument's test inputs can be monitored via the headphones output and the built-in loudspeaker.

### R&S®VTS compact video tester – the perfect test platform for manufacturing applications

The R&S®VTS compact video tester (Fig. 1) has been devised for testing AV interfaces in manufacturing applications, where cost and footprint play significant roles. The R&S®VTS comes without a touchscreen and is therefore extremely compact (1 HU, ½ 19"). As a result, it requires little space in test systems. It accommodates one test module and, thanks to the built-in PC, it can also be operated as a standalone unit. The tester can be controlled locally using a USB mouse and keyboard and an external monitor, or remotely over a LAN.

### An operating concept you will not want to miss

The R&S®VTE and the R&S®VTS use identical functional software, featuring the same intuitive and self-explanatory GUI (Fig. 2) for local operation and for remote control from a PC. The user selects the desired test application by pressing a tab on the touchscreen. Graphics can be displayed in full-screen mode to make them easier to view. Syntax errors and limit violations are clearly marked. In end-to-end tests, generator and analyzer applications can be run in parallel – and these are just a few of the many advantages afforded by the testers' convenient operating concept, which supports multiple languages (English, Chinese, Korean and Japanese). Running on Windows 7, the two testers also support capabilities provided by standard PCs, such as data transfer and network integration.



Fig. 1 The R&S®VTE video tester (top) and the R&S®VTS compact video tester (bottom) rely on the same modular concept. By employing appropriate interface test modules and software options, users can optimally configure the testers to meet the requirements of different applications in development and manufacturing.



### Test automation made easy

The R&S®VTE and the R&S®VTS have a VXI-11 remote control interface that accepts standard commands for programmable instruments (SCPI). This makes it easy to integrate the instruments into test systems. The integrated R&S®AVBrun test sequencer greatly simplifies automation of even complex test setups without the need to create source code. Composing test cases is very convenient using the tester's GUI on a PC to compile the individual test steps in the desired order. The tester then runs the test case fully automatically. Ready-to-run test cases are also available for specific applications.

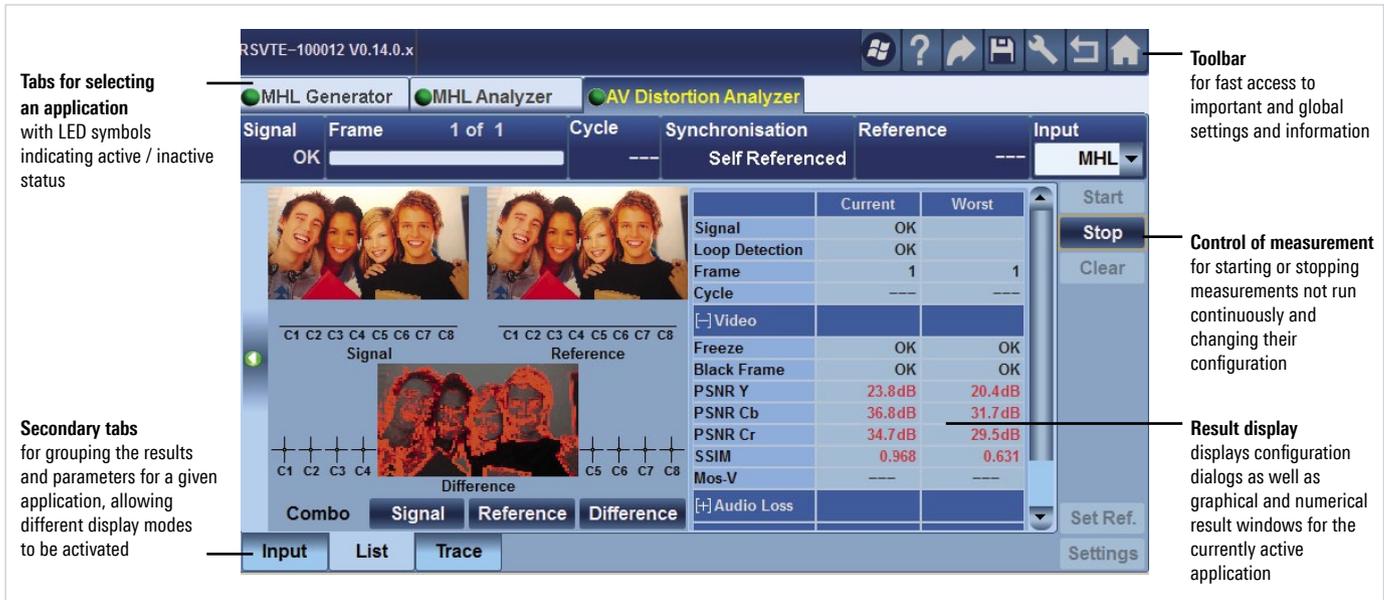


Fig. 2 Innovative graphical user interface (GUI) – shown here with the difference picture analysis function, which detects video degradation and analyzes it using suitable metrics.

### Test module for mobile high-definition link (MHL™) testing

Modern smartphones and tablets can record video content with their built-in HD cameras and receive video streams via mobile radio. To replay such audio and video content on high-definition multimedia interface (HDMI) flatscreen TVs – to view the content with friends, for example – a new video interface has been defined: the mobile high-definition link (MHL™). The mobile device's micro USB port is used as the physical MHL interface. While video is output to the flatscreen TV, the mobile device is charged via this interface.

The new interface requires numerous protocol and application tests in development and production. To support these tests, Rohde&Schwarz has developed the optional R&S®VT-B2350 MHL RX/TX module for the R&S®VTE and R&S®VTS video testers. Equipped with this module, the testers can perform protocol tests on MHL Version 1.2 source and sink interfaces. Audio and video are output in realtime on the tester or played out to a TV set over the tester's HDMI output. All relevant protocol parameters are presented in a straightforward manner:

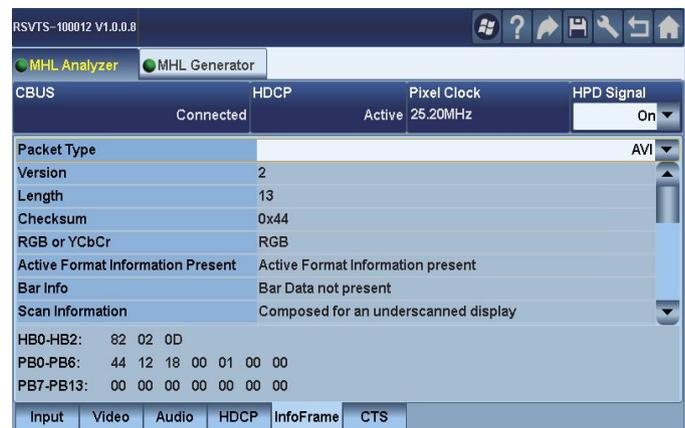
- Video timing parameters such as pixel clock and resolution in line with CEA-861
- Audio data
- High-bandwidth digital content protection (HDCP) status along with the keys used
- Auxiliary video information (AVI) InfoFrame (Fig. 3), audio InfoFrame, source product description (SPD) and MPEG InfoFrame

To test MHL sinks, user-defined multicolor patterns with resolutions in line with the MHL specification can be played out via the tester's generator output (Fig. 4). In addition to performing realtime measurements, the R&S®VT-B2350 MHL RX/TX module also provides raw test modes (additional software option) for MHL source and sink system tests in line with the MHL Compliance Test Specification Rev. 1.2 (Figs. 5 and 6).

### Test modules for any requirements: from MHL and HDMI to analog interfaces

The RX/TX test module for the MHL interface is the first module implemented for the R&S®VTE and R&S®VTS testers, with

Fig. 3 Output of auxiliary video information (AVI) InfoFrames.



many others to follow. Test modules for the HDMI 1.4c interface standard are scheduled to be available in the second half of 2012. Among other features, ultra-definition (UD) resolutions (4k x 2k) offered by high-end screens will be supported. In addition to routine protocol tests, these modules will enable tests in line with the MHL compliance test specification as well as application tests. An analog audio/video interface test module will be available for analyzing SD and HD composite and component signals. The testers will be equipped with two audio inputs for measuring audio parameters.

### Video and audio content analysis opens up completely new applications

Besides carrying out protocol tests and displaying the transmitted video and audio content, the R&S®VTE and R&S®VTS can optionally analyze the content received via any of their MHL, HDMI or analog AV inputs.

The R&S®VT-K2100 video analysis software option measures the timing and level of each video signal component in real-time (Fig. 7). This can be used to verify correct transmission of color signals, for example. The R&S®VT-K2110 AV inspection and R&S®VT-K2111 AV distortion analysis options are available to analyze picture quality (see box on page 36). They present results in graphical form and deliver objective results in realtime, including peak signal-to-noise ratio (PSNR), structural similarity (SSIM) and the mean opinion score (MOS-V) derived from SSIM. Plus, they detect visible errors in the video image as well as the picture failure point (PF). R&S®VT-K2110 and R&S®VT-K2111 are available exclusively for the R&S®VTE video tester. An audio analysis option will be available in the second half of 2012 to deliver conclusive results on audio level, frequency, phase, signal-to-noise ratio (SNR), distortion, crosstalk and other relevant parameters.

Fig. 4 Realtime output of user-defined multicolor patterns with resolutions in line with the MHL specification.

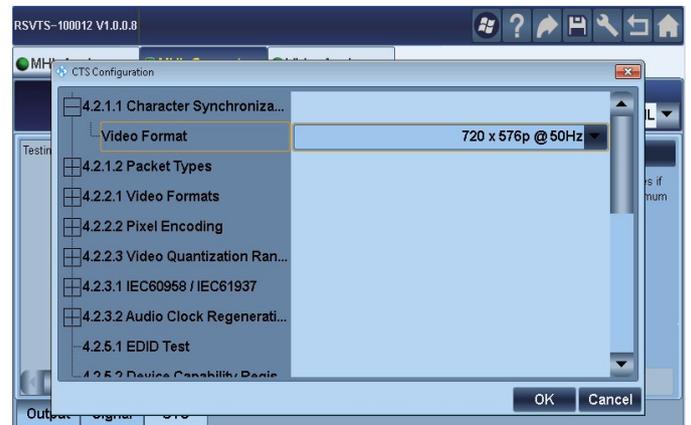
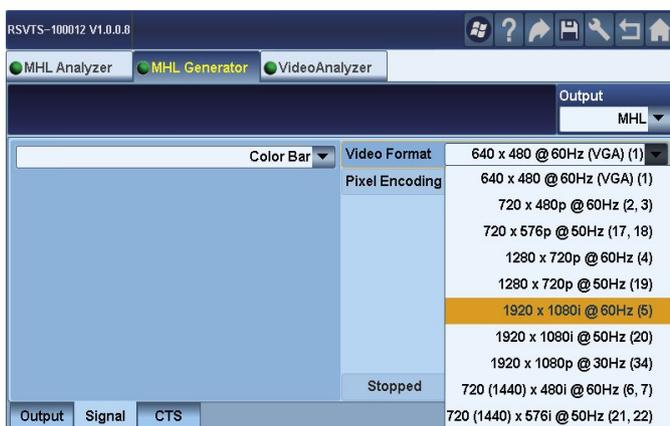
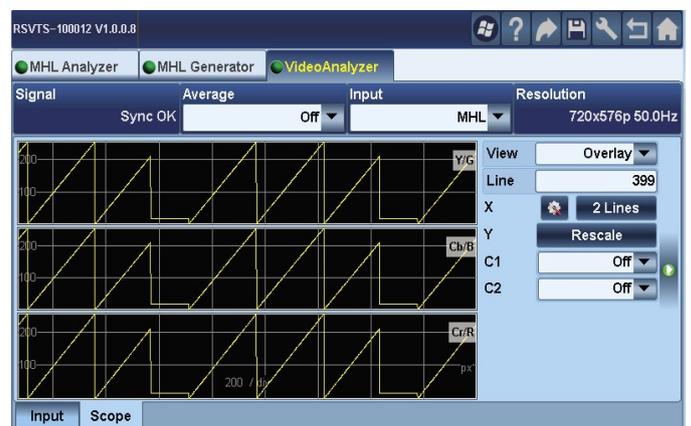


Fig. 5 The tester can optionally output TMDs raw data, which is required for sink system tests in line with the MHL compliance test specification (CTS).



Fig. 6 The tester can optionally analyze TMDs raw data during source system tests (for example on smartphones) in line with the MHL compliance test specification (CTS).

Fig. 7 The level and timing of the digital component signal can be measured in the time domain.



## Detecting and analyzing video degradation

The R&S®VT-K2110 AV inspection and R&S®VT-K2111 AV distortion analysis options detect video degradation as is typically caused by transmission errors. Examples of such degradation include blocking, picture freeze and picture loss.

### Testing terminal equipment

When testing the RF frontend of terminal equipment for immunity to interference during AV transmissions at the development stage, for example, there is a need for automatic detection of video degradation. The AV inspection and AV distortion analysis options rely on difference picture analysis to accomplish this: The picture sequence to be analyzed is compared in realtime with the corresponding picture sequence of an ideal reference signal. For mobile phones, the test is carried out as follows (see Fig. 8):

- 1 A looped video signal is transmitted over an undisturbed link, decoded in the mobile phone's receiver and transferred to the test module via the phone's AV outputs. The video tester stores the undisturbed signal as a reference signal.
- 2 In a second step, defined interference is superimposed on the transmission link. The disturbed video signal is fed to the tester's analysis unit in order to verify how it affects the mobile phone's video decoding performance.
- 3 The video tester synchronizes the disturbed video signal and the ideal reference signal and displays differences between the two signals in graphical form, plus it calculates numerical results for them using suitable metrics.

### Difference picture analysis

In difference picture analysis, the tester calculates the difference between two pictures and presents the results graphically, with differences marked red. Plus, mathematical evaluation is carried out based on two metrics commonly used in the industry: peak signal-to-noise ratio (PSNR) and structural similarity (SSIM). This makes the evaluation process reproducible and suitable for automation.

The video tester calculates the PSNR and SSIM metrics for individual pictures in each case. To determine visible degradation across a sequence of pictures, temporal masking effects can be taken into account by defining thresholds for a given sequence. This makes it possible to automatically analyze a picture sequence for visible degradation as well as for the type of degradation that various test standards refer to as the picture failure point (PFP).

More information about video degradation detection and analysis, especially for video over LTE applications, can be found in the webinar "Video over LTE – testing the next step in the end user experience" at [EETimes.com](http://EETimes.com).

## Video over LTE testing

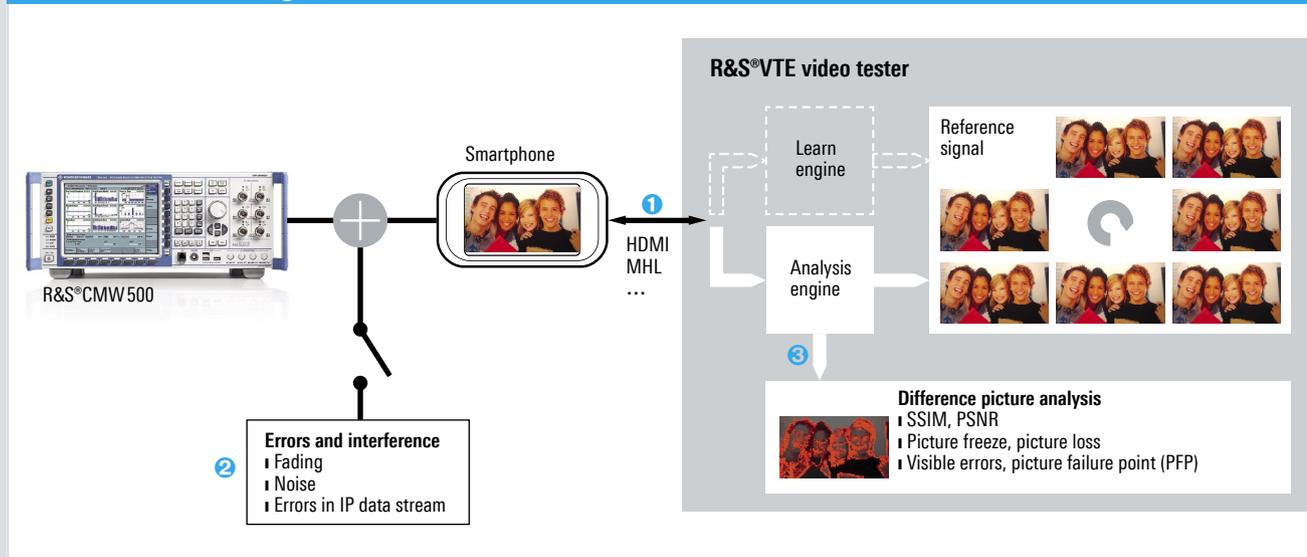


Fig. 8 Schematic representation of video degradation analysis for video over LTE transmissions.



Fig. 9 Test setup with an R&S®CMW500 tester and an R&S®VTE video tester for carrying out application tests on smartphones.

## Applications

### Testing digital AV interfaces for conformance with standards

The protocol on the AV interfaces of consumer electronics equipment is tested for standard-compliant behavior during development and certification to ensure the equipment's interoperability with other components. Especially at the development stage, it is crucial for test equipment to be able to display protocol parameters in realtime, with simultaneous decoding and analysis of the media content.

One special application is testing in line with the MHL compliance test specification (CTS) as a final interoperability test. CTS tests call for raw data analysis. The R&S®VTE and R&S®VTS now make it easy to perform this task.

### End-to-end (E2E) testing of video over LTE

The LTE mobile radio standard enables applications such as video conferencing and video streaming on mobile devices. To check the mobile device's immunity to interference for video transmissions, interference is superimposed on the transmitted signal. This is done by embedding errors in the IP data stream or by introducing noise or fading to degrade RF signal transmission over the air interface.

The mobile phone decodes the incoming video data and outputs it to the R&S®VTE via the MHL or HDMI interface. The R&S®VTE reliably detects video degradation – either operator-controlled or using automatic test routines – and supports the operator in objectively assessing video quality.

Fig. 9 shows a typical setup for end-to-end testing of video over LTE. In the second half of 2012, the R&S®VTE video tester will also be available as an option for the R&S®CMW-PQA performance measurement system for testing the robustness of cellular video transmissions.

## Summary

The R&S®VTE video tester and the R&S®VTS compact video tester from Rohde&Schwarz are setting new trends in the development and manufacturing of consumer electronics equipment with AV interfaces. The two testers are already available, as is a first test module (for the MHL standard). Two more modules (for HDMI and analog AV interface testing) plus another base unit are to follow in the second half of 2012. The new base unit and modules will be presented in a future issue of NEWS.

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