Digital video signal generator for testing state-of-the-art TV display equipment

The R&S®DVSG offers the widest range of interfaces and test signals currently provided by a single unit. It generates both analog and digital video and audio signals and features an MPEG-2 transport stream player and recorder.

Interfaces and signals even for the most demanding scenarios

The days of the well-known cathode-ray tube are nearly over, and new display technologies are rapidly conquering the market (see page 48). New interfaces and new signals are being created in this process, which means that new test and measurement requirements have to be met in development, production and quality assurance. The new R&S®DVSG digital video signal generator (FIG 1) has been designed to meet these requirements. It offers all established analog and digital video and audio interfaces (FIG 3) as well as SDTV and HDTV signals for testing modern TV displays and projectors. The test signals are available at all interfaces simultaneously – provided the signal and the interface type are compatible – which further simplifies tests. A special feature of the generator is its ability to output complex moving-picture sequences with high resolution. This is a prerequisite for testing important fundamental characteristics of modern display equipment. The R&S®DVSG therefore includes test signals specially developed for this purpose (FIG 6). This allows the fast and easy testing of format conversion (including de-interlacing), motion blur compensation, overdrive, noise suppression and many other functions.

FIG 1 The R&S®DVSG is a high-precision signal source containing all state-of-the-art digital interfaces as well as the appropriate test signals, including HD signals and moving-picture sequences. It can also be used as a pure transport stream player and recorder.
The R&S®DVSG generates audio and video signals in two ways:
- Sequential, realtime output of uncompressed pictures stored in its memory
- Decoding of video and audio data contained in transport streams (live or from hard disk)

With sequential output, each pixel is individually defined. This makes it possible, for example, to generate continuous and stepless brightness and color variations. The set of signals supplied with the generator is free from compression artifacts and has been carefully generated. The user can easily expand the R&S®DVSG set of signals as required for the intended application. For example, any pictures in BMP format created on a PC can be used to generate the video signal in the R&S®DVSG. This functionality is useful both in development and production.

The transport stream decoding function enables the playback of video and audio contents of any transport stream. FIG 2 shows the graphical user interface (GUI) of the AV signal player option. The decoder function is particularly useful in development and quality assurance, as it allows convenient

1) The only exception: The SCART and the D4 interface cannot be driven simultaneously.
2) HDTV signals, for example, cannot be output on a composite interface.
New display technologies call for new signals and made-to-measure test equipment

The most significant technical innovations ...

So far, the signal to be displayed and the display equipment were matched to each other. In Europe, 50 fields were transmitted per second and in the U.S. 59.94 fields, with 576 and 480 active lines per frame, respectively. A cathode-ray tube was used to generate the picture. With the cathode-ray tube, the individual pixels and lines lit up only very briefly when activated (for a period significantly shorter than the field duration of 20 ms / 16.7 ms), resulting in a slightly perceptible flickering of the picture. The interfaces of the display equipment were designed for standard-resolution analog signals.

Nowadays, display equipment based on LCD, plasma or DLP technology is available with significantly higher resolutions (up to 1080p in consumer products), see FIG 4. Same as with the cathode-ray tubes, resolution is fixed, but not the same for all display equipment. To achieve increased brightness and suppress perceptible line structures, progressive formats are normally used. The display does not flicker, since the individual pixels light up for almost the entire duration of a frame. The display equipment has inputs for RF signals such as DVB-T or ATSC/8VSB, as well as interfaces for connecting local signal sources. The HDMI interface in particular is being more and more widely used, as it supports the digital transmission of video and audio signals simultaneously and in high quality. Many manufacturers also integrate additional methods for improving the picture quality. These are intended, for example, to suppress noise, blocking and film judder, or to improve contrast, definition and color.

... and their consequences

In newer equipment, the picture resolution and the physical resolution of the display equipment often do not match, e.g. in the case of an SDTV signal displayed on a modern LCD. To utilize the entire screen area, the resolution of the received signal has to be increased (scaled) to match the resolution of the display equipment. Interlaced formats also have to be converted to progressive formats. The quality of the displayed picture therefore depends on the quality of the format conversion carried out in the display unit. Moreover, the fact that, with modern display technologies, the individual pixels are activated for almost the entire frame duration results in perceptible motion blur (FIG 5) in the case of moving objects. Manufacturers attempt to reduce or suppress motion blur using techniques such as a 100 Hz frame refresh rate with repeated intermediate frame calculation. Another effect is that the individual pixels require a certain time to reach their full luminous intensity. This characteristic can be minimized using the overdrive technique, in which the pixels are initially overdriven so that they reach their intended intensity quicker.

<table>
<thead>
<tr>
<th>Conventional technology</th>
<th>New technology</th>
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<tbody>
<tr>
<td><strong>Image generation</strong></td>
<td></td>
</tr>
<tr>
<td>Cathode-ray tube (576 / 480 lines, interlaced)</td>
<td>Plasma, LCD and DLP technology (typical physical TV resolutions: 1366 × 768, 1920 × 1080, progressive)</td>
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<tr>
<td><strong>Interfaces</strong></td>
<td></td>
</tr>
<tr>
<td>SDTV only: composite, components, S-Video, SCART</td>
<td>SDTV and HDTV: components, DVI, HDMI</td>
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<tr>
<td><strong>Video format</strong></td>
<td></td>
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<tr>
<td>576 / 480 × 720, interlaced</td>
<td>1280 × 720, 1920 × 1080 and others, with different frame refresh rates, progressive or interlaced</td>
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<tr>
<td><strong>Image enhancement</strong></td>
<td></td>
</tr>
<tr>
<td>Suppression of noise, blocking and film judder; improvement of contrast, definition, color, etc.</td>
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FIG 4 Main differences between conventional and new display technologies

Motion blur

![Motion blur diagram](image)

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FIG 5 Display of moving elements. Top: The photo of the horizontally scrolled text “R&S” shows the motion blur on the LCD display. No blur is visible on the CRT display. Bottom: Illustration of the perception of the edge of a horizontally scrolled bar to explain the problem of motion blur. In this example, four viewing times (t1 to t4) have been selected for each frame (A, B and C).
testing of how display equipment handles complex, critical or typical scenes as encountered in everyday use. By using the universal transport stream format, virtually any live situation can be simulated. All that is needed is a recording of an arbitrary transport stream containing the required signals, which is possible with any transport stream recorder.

The R&S®DVSG features an integrated transport stream player and recorder. Transport streams can be recorded and their video and audio contents utilized for signal generation using only a single unit. With this application, the decoder integrated in the R&S®DVSG can additionally be used for monitoring. For this purpose, a program in the transport stream is displayed on a monitor connected to the R&S®DVSG and compared with the picture output by the equipment under test. The transport stream player and recorder is a valuable tool for testing multiplexers, decoders and all other components used in transport stream processing. In conjunction with a modulator, e.g. the R&S®SFE or the R&S®SFE100, the R&S®DVSG forms a compact and powerful system for testing set-top boxes.

Summary

New challenges have to be met in the development and testing of modern TV display equipment. These include the requirement for high-precision signal sources containing all state-of-the-art digital interfaces as well as the appropriate test signals, including HD signals and moving-picture sequences. The new R&S®DVSG digital video signal generator from Rohde & Schwarz has been specially designed to meet these requirements. It can also be used as a pure transport stream player and recorder, an application for which it is particularly suited due to its extensive signal libraries and excellent price/performance ratio. The R&S®DVSG is an ideal choice not only in the development and production of TV displays, but also in servicing as well as for test houses and professional studio applications.

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