# Testing of Analog Video Component Signals

## Application Note

**Products:**

- R&S®VTC
- R&S®VTE
- R&S®VTS
- R&S®BTC

Despite the now standard digital distribution of video signals, analog video signals are still an integral part of AV terminals in the home.

This application note covers the fundamentals of analog component signals and shows how the signal quality can be measured with the measuring equipment from Rohde & Schwarz.

**Note:**

Please find the most up-to-date document on our homepage http:\\www.rohde-schwarz.com/appnote/7MH107.

Application Note
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5.2015 – 7MH107_0E

ROHDE&SCHWARZ

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# 1 Introduction

Before digital video interfaces such as HDMI and MHL were introduced into homes, analog component signals were the only way to exchange video signals with high quality and in a wide range of resolutions. For this reason, analog interfaces are well established in home consumer devices and are often still included in new video equipment to maintain compatibility. As a result, the need for suitable T&M equipment remains undiminished.

This application note provides an overview of the video component technology and describes in detail the tests and measurements needed for this technology. It includes a discussion of suitable test signals and the signal supply as well as descriptions of a wide variety of automated measurements.

Finally, step-by-step instructions are provided for recording and ensuring the quality of component signals using Rohde & Schwarz video test equipment.

# 2 Basics

## 2.1 GBR and YPbPr Color Systems

Video component signals are defined in two primary color systems – GBR and YPbPr.

**GBR** signals represent the natural colors of a picture in the form of its basic green, blue and red components. This color system is at the beginning and end of the transmission chain for color images. Every camera supplies GBR signals for all pixels of the image. And every display uses these signals to regenerate the original colors. In homes, GBR signals are primarily encountered in PCs (VGA). In the case of set-top boxes, analog GBR signals are usually only encountered at the SCART output.

**YPbPr** signals split the color into a brightness information Y and two color difference signals, Pb and Pr. Pb is calculated from the difference between blue and luminance, and Pr from the difference between red and luminance. The use of color difference signals can be traced back to the introduction of color television. They make it possible to transmit a signal that is compatible with black-and-white televisions. In addition, color difference signals have an advantage over GBR because they can be used to reduce the resolution of the color information as compared with the luminance information. In the case of analog component signals, this is done by cutting the transmission bandwidth for the color difference signals in half. Because the human eye is less sensitive to color information, this saves valuable transmission bandwidth without impairing the picture quality. YPbPr interfaces are found in every home consumer device that supports video components.

GBR and YPbPr signals can be converted using simple mathematics. An example of this is provided in Equation 2 1 and Equation 2 2 for converting GBR to YPbPr for the color spaces used in SD and HD television.

$$\begin{aligned}
Y &= 0.299*R + 0.587*G + 0.144*B \\
Pb &= -0.169*R - 0.331*G + 0.500*B \\
Pr &= 0.500*R - 0.419*G - 0.081*B
\end{aligned}$$

**Equation 2 1: GBR to YPbPr conversion for SDTV (720 x 480; 720 x 576).**

$$\begin{aligned}
Y &= 0.213*R' + 0.715*G + 0.072*B \\
Pb &= -0.115*R' - 0.385*G' + 0.500*B \\
Pr &= 0.500*R' - 0.454*G - 0.046*B
\end{aligned}$$

**Equation 2 2: GBR to YPbPr conversion for HDTV (1280 x 720 and 1920 x 1080).**

When using test signals, it must be noted that not all level combinations that are possible in the YPbPr color format can be mapped to the GBR color format. However, as long as the YPbPr color format is not exited, these level combinations, also called illegal colors, are not harmful for testing YPbPr signals. However, conversion to the GBR color format would lead to level deviations and visible color errors. Frequently, video equipment converts YPbPr to GBR during the internal video processing, even when it finally provides YPbPr at the output. In this case, YPbPr signals would show level deviation at the output. This must be taken into consideration when generating proprietary test signals. The test signals provided by Rohde & Schwarz for measurements of component signals [3] are designed in such a way that these effects cannot occur.

A few notes regarding notations:
The notations Y‘PbPr as well as G‘B‘R’ are frequently seen. The prime indicates that the signals underwent a gamma correction to compensate the nonlinearity of camera systems. The notations YCbCr and Y’CbCr describe color differential signals in the digital domain. Where there is no distinction for the primary color system, GBR and G’B’R’ are used for analog and digital domain.

## 2.2 Level

Fig. 2-1 and Fig. 2-2 show the levels for YPbPr and GBR signals.

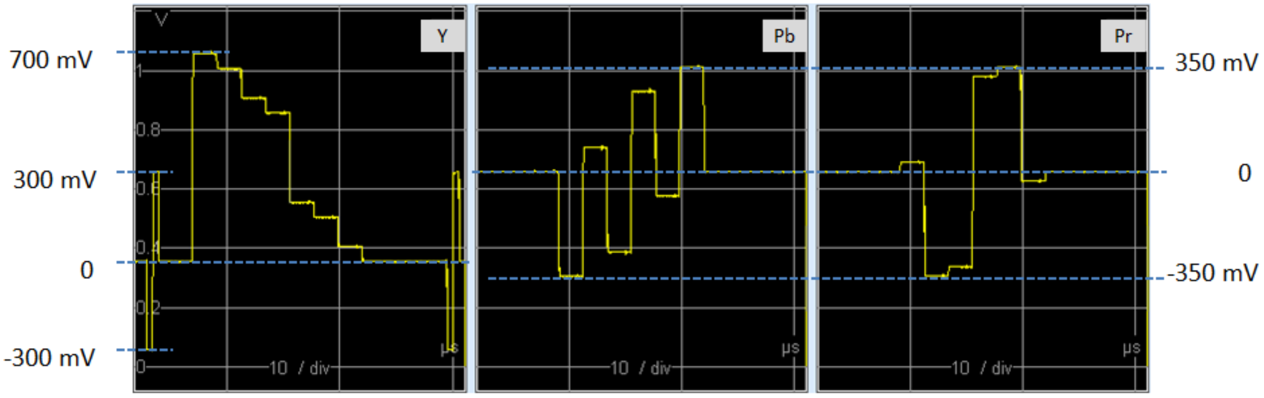


**Fig. 2-1: YPbPr signal levels in line with CEA-770.2/3, ITU-T BT.709-5 and SMPTE-274M.**

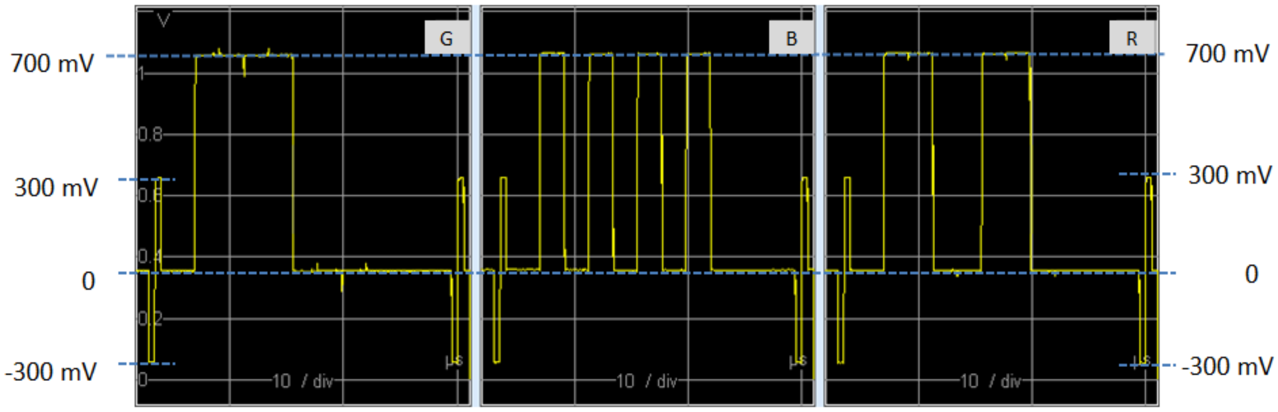


**Fig. 2-2: GBR signal levels in line with SMPTE-274M.**

Due to historical reasons, sometimes component formats with 525 lines come with a signal level of 714 mV and a sync level of 286 mV (40IRE). For North America, the black level is, in addition, boosted to 54 mV. In this case, the peak level is reduced to 660 mV (see Fig. 2-3).

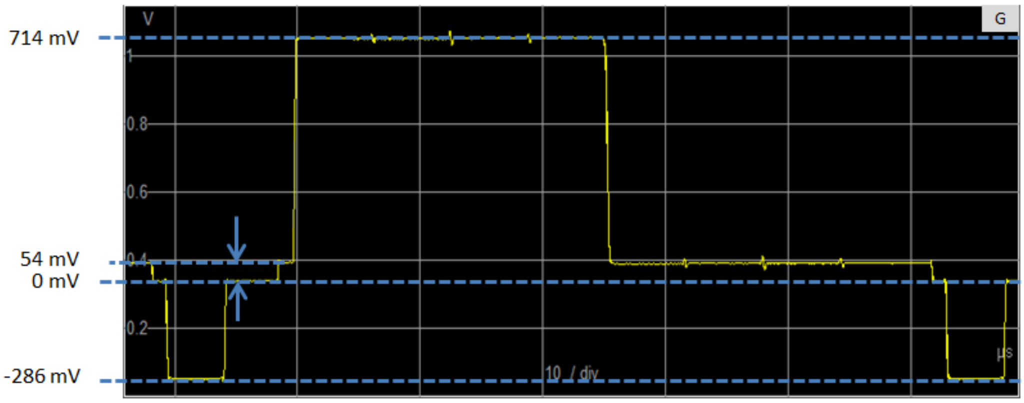


**Fig. 2-3: Green component of a 525-line GBR signal with 714 mV peak level and boosted black.**

In all examples shown here, the actual position of the black level is significantly shifted against the nominal reference level of 0 V. CEA770.2/3 permits this. Accordingly, the DC level may deviate by as much as +/– 1 V from the reference value of 0 V. Component outputs on set-top boxes commonly output the signal with an offset. Thanks to its DC coupling, the scope on the R&S®VT video analyzer allows you to check whether the level still lies within the specifications.

## 2.3 Synchronization

YPbPr signals normally contain sync pulses only in the Y channel (see CEA-770.3). However, some specifications allow the sync pulses to be inserted into all components (see SMPTE296M). The GBR signal is similar. Its sync pulse can also be transmitted in either one or all channels. In contrast, VGA interfaces split the sync pulses into H and V and transmit the signals over two separate lines (see VESA and Industry Standards and Guidelines for Computer Display Monitor Timing (DMT) Version 1.0, Revision 11 – May 1, 2007).

In the case of SDTV, the sync pulse is implemented as a bi-level pulse. The start of the video line is indicated by the falling slope. In contrast, HDTV uses a tri-level sync (see Fig. 2-4). This is significantly less sensitive to noise and DC offsets, and is therefore suited to the more stringent requirements of the higher-frequency HDTV signal. In this case, the start of the video line is indicated by the rising slope.

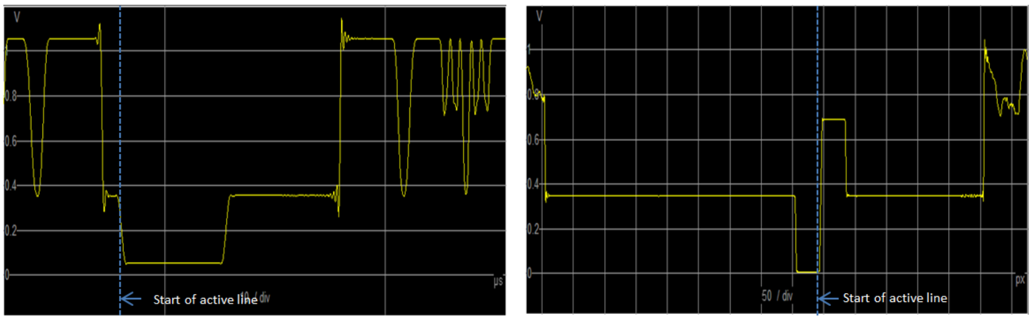


**Fig. 2-4: Bi-level and tri-level sync pulses.**

# 3 Test Signals

Automated measurements require special test lines. The Rohde & Schwarz combined test pattern contains all of these test lines in one test pattern for measurements of both YPbPr and GBR signals.

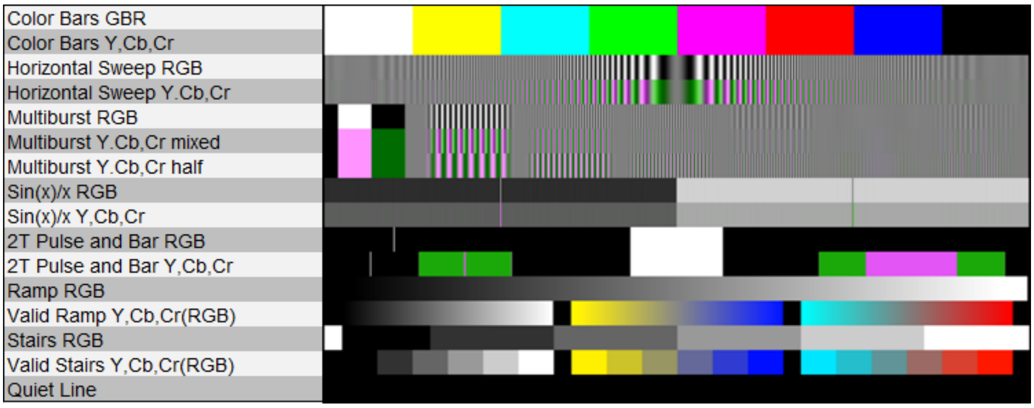


**Fig. 3-1: Rohde & Schwarz combined test pattern.**

Appendix B describes which measurements are performed on which test lines.

All test scenarios in digitally based video equipment require the test patterns in compressed format. However, the associated DCT block building makes test lines around signal changes unusable for measurements (see Fig. 3-2).

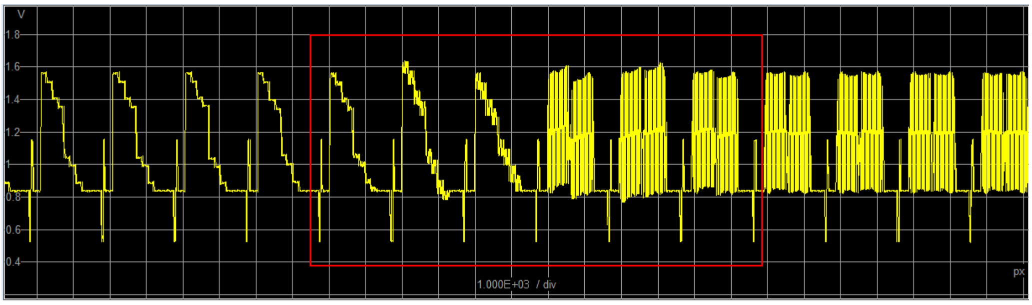


**Fig. 3-2: Errors resulting from compression in test lines within the transition range from multiburst to sweep.**

All test lines are therefore inserted in multiples in blocks. Lines in the middle of these blocks are not impaired by coding artifacts and can be used for the measurements. By default, the R&S®VTC/VTE/VTS/BTC video analyzer is preconfigured appropriately for the Rohde & Schwarz combined test patterns. Automatic resolution detection makes it unnecessary to configure or adjust the line positions. If the default setting is changed, it can be restored at any time by pressing the Reset button (see section 6.3).

Test patterns are available for all standard resolutions. For details, refer to Appendix A. There you will also find a description of the exact position of the test lines in the various resolutions.

The test patterns are available as a transport stream and as a JPG file. This covers all test scenarios described in section 5.

# 4 Relevant Standards

| | |
|---|---|
| ITU-R BT.470-6 | Conventional Television Systems |
| ITU-R BT.601-5 | Studio Encoding Parameters of Digital Television for Standard 4:3 and Widescreen 16:9 Aspect Ratios |
| ITU-R BT.709-5 | Parameter Values for the HDTV Standards for Production and International Programme Exchange<br>(Note: Part 1 of this document describes the old European HDTV system and is no longer in use) |
| ITU-R BT.1700 | Characteristics of Composite Video Signals for Conventional Analogue Television Systems |
| ITU-R BT.1439-1 | Measurement Methods Applicable in the Analogue Television Studio and the Overall Analogue Television System |
| | |
| SMPTE ST 125-2013 | SDTV Component Video Signal Coding 4:4:4 and 4:2:2 for 13.5 MHz and 18 MHz Systems |
| SMPTE 170M-2014 | Composite Analog Video Signal NTSC for Studio Applications |
| SMPTE 253M-1998 | Three-Channel RGB Analog Video Interface |
| SMPTE 274M-2008 | 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates |
| SMPTE 296M-1997 | 1280 x 720 Scanning, Analog and Digital Representation and Analog Interface |
| | |
| CEA-770.2-D | Standard Definition TV Analog Component Video Interface |
| CEA-770.3-E | High Definition TV Analog Component Video Interface |
| CEA-861-D | A DTV Profile for Uncompressed High Speed Digital Interfaces |
| | |
| Vsisv1r2 | Video Signal Standard (VSIS) |
| DMTv1r11 | VESA and Industry Standards and Guidelines for Computer Display Monitor Timing (DMT) Version 1.0, Revision 11 – May 1, 2007 |

# 5 Test Scenarios

The connections for performing measurements with an R&S®VTC/VTE/VTS/BTC video analyzer are easily made. To prevent false results, however, a few basic principles must be followed.

The 75 ohm BNC cables that feed the component signal to the analyzer must be equal in length to prevent measurement errors during measurements of delay.

RCA connectors are typically used for the component outputs on the UEs. However, the stability of these connections is often a critical factor. Therefore, only high-quality RCA connectors should be used. Cables that include a direct RCA to BNC adaptation are preferred. Alternatively, an RCA to BNC adapter can be used on the DUT. RCA cables with an RCA to BNC adapter on the analyzer side should be avoided. The quality of these cables is typically not suited for precision measurements.

During the tests, it must be consistently ensured that the test pattern resolution matches the resolution of the video interface on the DUT. Although DUTs can convert formats, the conversion typically ignores the Nyquist criteria. This results in aliasing effects, in particular for frequency response measurements.

The test signal feed is dependent on the DUT. The sections below describe a few typical scenarios.

## 5.1 Set-Top Box with RF Signal Feed

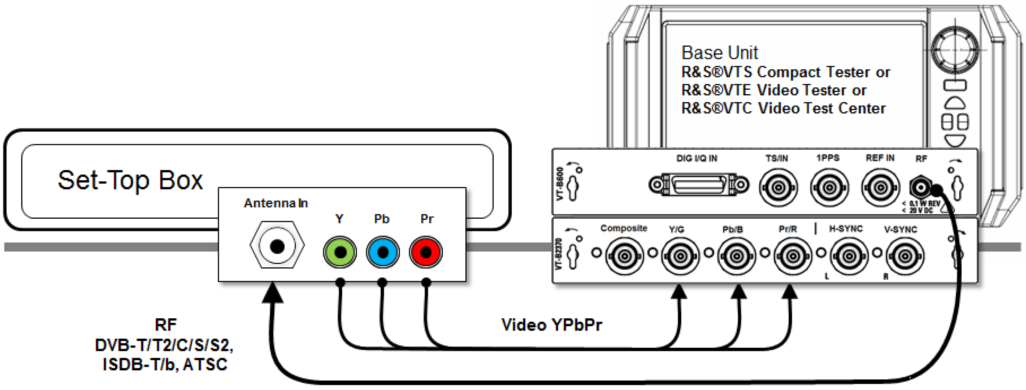


Fig. 5-1: Testing a set-top box with RF signal feed.

In this example, the test signal is applied as a transport stream via a modulator. As shown in Fig. 5-2, this can take place via the optional R&S®VT-B600 broadcast modulator with integrated transport stream generator. The type of modulation is dependent on the DUT frontend. Many receivers expect the signaling in the transport stream to match the transmission standard. For these situations, a SW tool is available for adapting the streams.

The same transport streams can be used for IPTV receivers. The signals are then applied via a server or IP streamer. An appropriate tool is available here: http://www.rohde-schwarz.com/en/product/tsstream-productstartpage_63493-51392.html.

## 5.2 Set-Top Box with USB Signal Feed

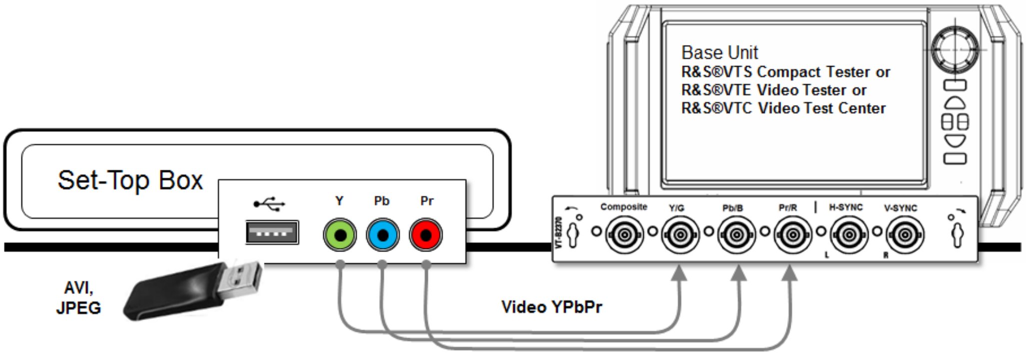


Fig. 5-2: Testing a set-top box with USB signal feed.

Receivers frequently allow video signals to be played back from a USB storage device. The necessary test patterns are also available in JPEG format.

## 5.3 DVD Player with Signal Feed via DVD or BD

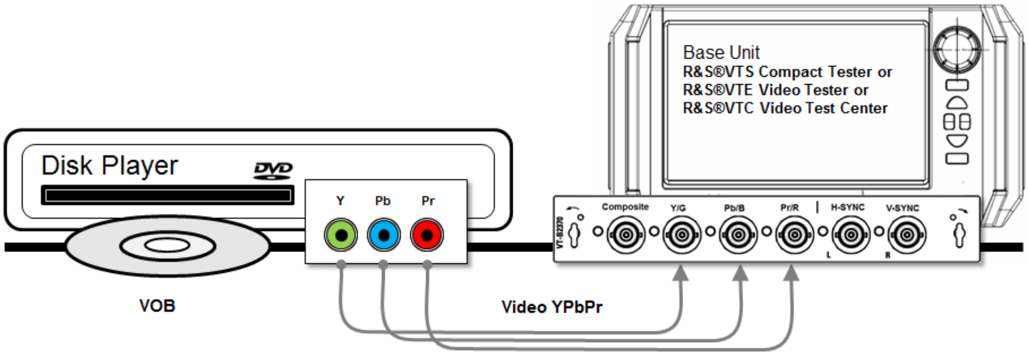


Fig. 5-3: Testing a DVD player with signal feed via DVD.

For DVD or Blu-ray players, the JPEG test signals can be burned to DVD or Blu-ray disc by using the appropriate tools. Alternatively, disk players frequently allow files to be played back from USB storage devices, as described in the previous scenario.

## 5.4 Laptop with VGA Interface

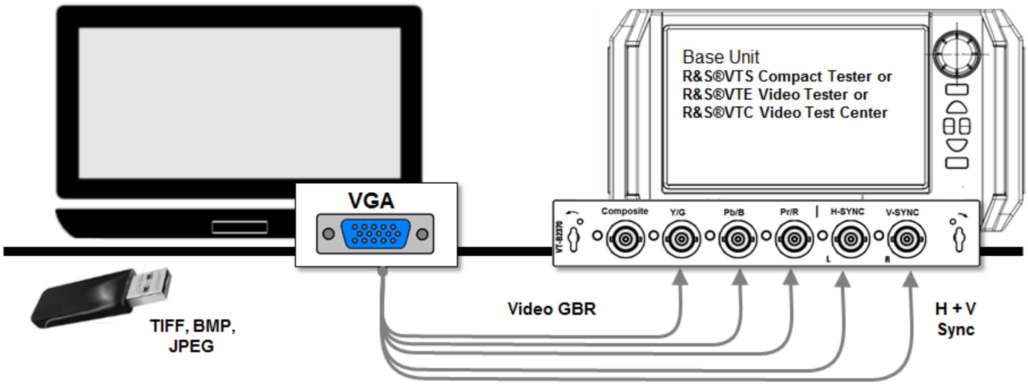


**Fig. 5-4: Testing a VGA interface with USB signal feed.**

In the case of VGA signals, the H and V sync pulse feeds are in separate lines. Therefore, VGA adapter cables have five BNC outputs. The sync lines are connected to the jacks labeled "H-Sync" and "V-Sync". These are enabled via the "External Sync" configuration in the input view on the video analyzer (see Fig. 6-2).

For measuring, the test signal must be displayed in full-screen mode on the VGA interface. The required tools are available in every operating system as accessories. However, the interface resolution must exactly match that of the test signal. As described at the beginning of section 5, scaling changes the characteristics of the test signal and makes it unusable for precision measurements.

Otherwise the video measurements on VGA interfaces run exactly the same as on RGB outputs on TVs. Even though measurements on the external sync signals are not supported, they can be displayed in the scope view.

# 6 Operation of the R&S®VTC/VTE/VTS/BTC Video Analyzers

## 6.1 Preparatory Steps

### Enable and open the "Video Analyzer" application

Ensure that the **Video Analyzer** application is enabled. If it is not, enable it as follows:

- In the right pane on the "Applications" tab, touch and hold the icon of an application
- until the color of the icon changes. Slide it into the left pane of the home screen and release it.

To open the application, click the **Video Analyzer** icon.

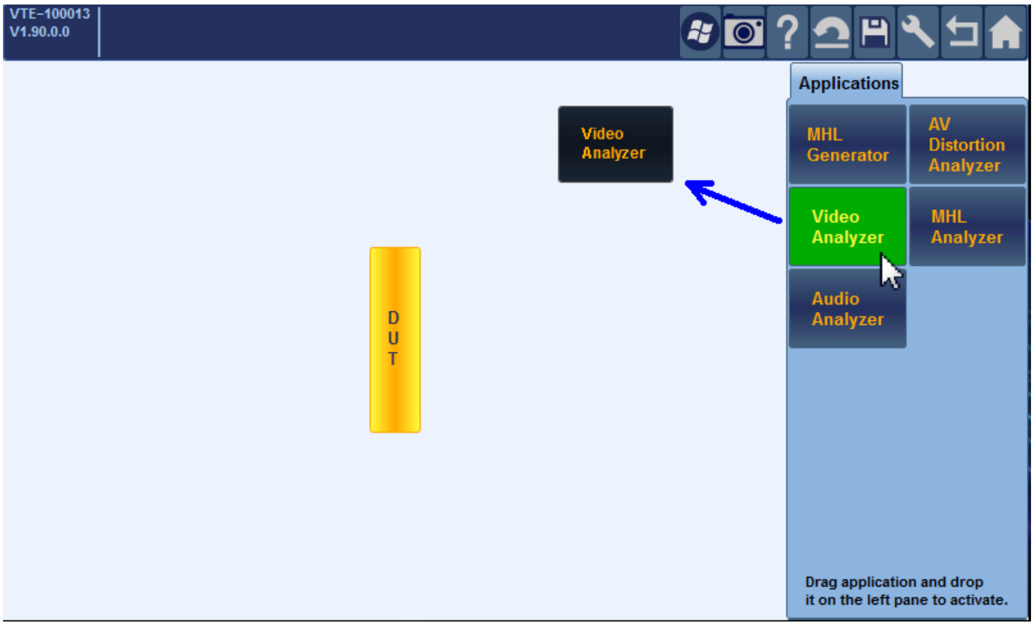
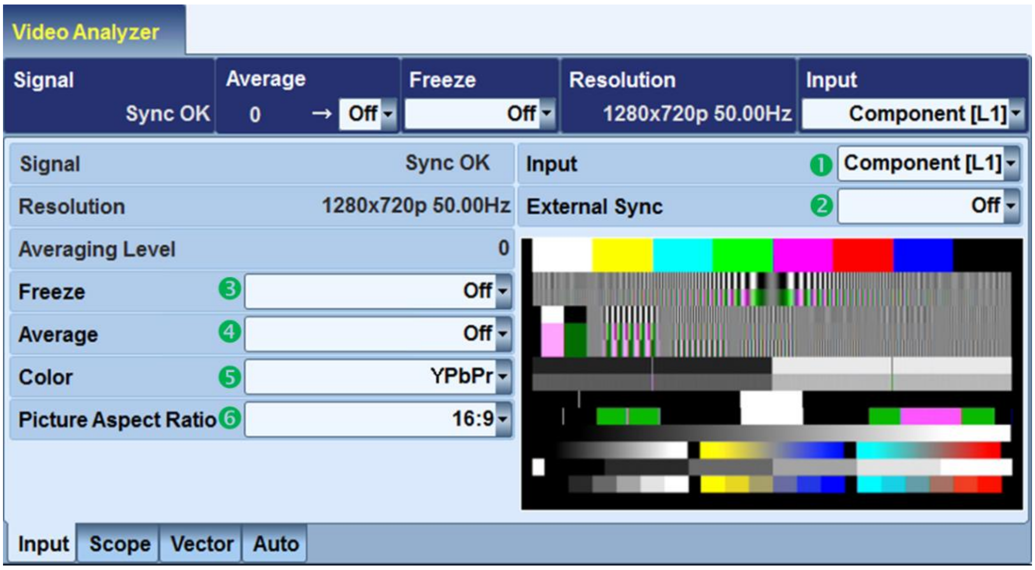


**Fig. 6-1: R&S®VTS/VTE/VTC home screen.**

### Select and configure the signal input

In the analyzer view, go to the **Input** tab and define the settings as follows:



Signal: Sync OK
Average: 0 → Off
Freeze: Off
Resolution: 1280x720p 50.00Hz
Input: Component [L1]

Signal: Sync OK
Resolution: 1280x720p 50.00Hz
Averaging Level: 0
Freeze ③: Off
Average ④: Off
Color ⑤: YPbPr
Picture Aspect Ratio ⑥: 16:9
Input ①: Component [L1]
External Sync ②: Off

Fig. 6-2: Video analyzer input view.

1. Select **Component** as the signal input.
2. Set the external synchronization to Off in the case of video signals with embedded synchronization pulses.
3. Set freeze to Off. This option can be used later to freeze measurement results.
4. Set the desired averaging to improve the stability of the measured value output in the case of noisy signals.
5. Set the color format of the signal – YPbPr or GBR. This setting defines which analysis will be performed and therefore must be set correctly. You can verify that the color format is set correctly by checking that the color replication in the preview picture is correct. Fig. 6-2 shows a correctly configured color format. If the color format is set incorrectly, the preview picture will look like the following:

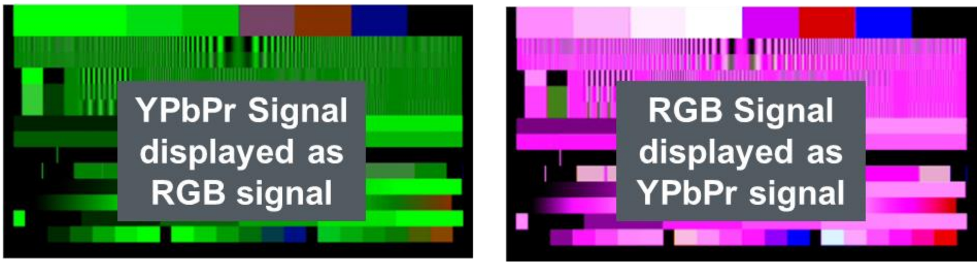
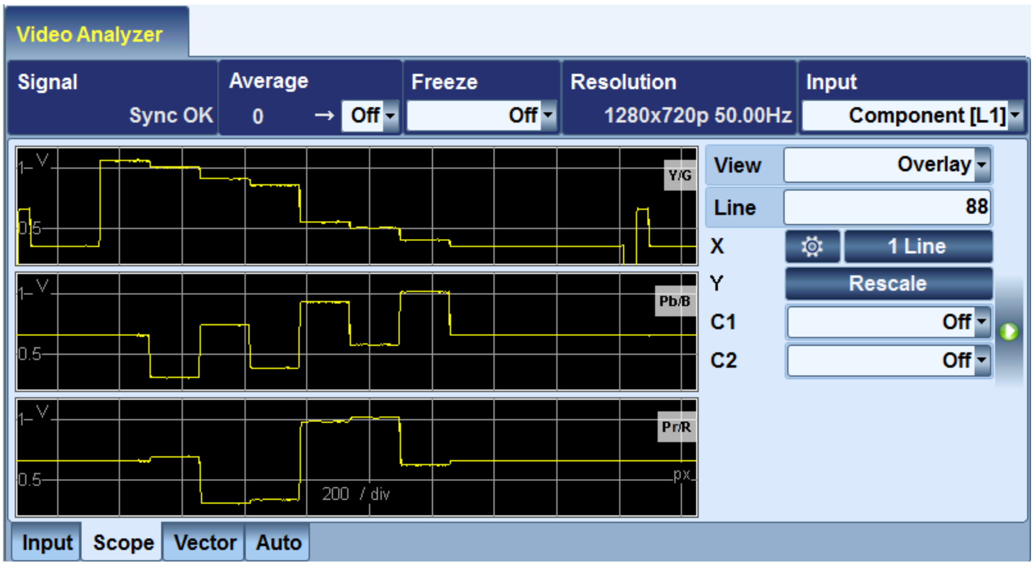


Fig. 6-3: Rohde & Schwarz combined test pattern display with incorrectly set color format.

6. Select the picture aspect ratio for the signal. This setting serves only to display the correct picture aspect ratio in the preview picture. It will not affect the analysis itself.

Once all settings have been made and a valid signal is present, the favorites bar will display "Sync OK" under **Signal** and the signal resolution under **Resolution**. If this is not the case, check the cabling and use the scope view to determine whether the expected signal is actually present.

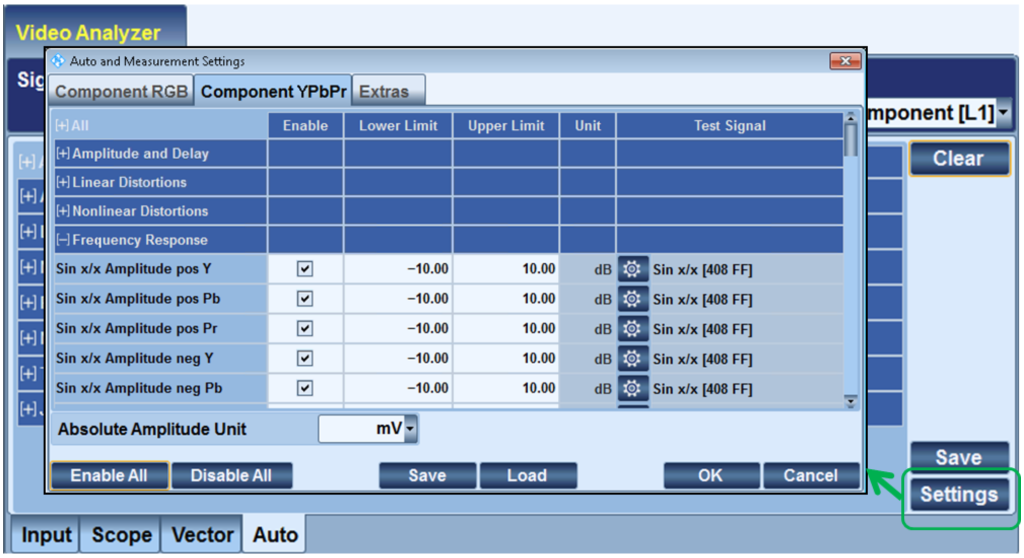


Signal: Sync OK
Average: 0 → Off
Freeze: Off
Resolution: 1280x720p 50.00Hz
Input: Component [L1]
View: Overlay
Line: 88
C1: Off
C2: Off

**Fig. 6-4: Display of the YPbPr standard color bar in the scope view.**

## 6.2 Configuring the Analyzer

To configure the analyzer, open the **Auto** view and click the **Settings** button to open the "Auto and Measurement Settings" dialog box (Fig. 6-5).



| [+] All | Enable | Lower Limit | Upper Limit | Unit | Test Signal |
|---|---|---|---|---|---|
| [+] Amplitude and Delay | | | | | |
| [+] Linear Distortions | | | | | |
| [+] Nonlinear Distortions | | | | | |
| [–] Frequency Response | | | | | |
| Sin x/x Amplitude pos Y | ☑ | −10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude pos Pb | ☑ | −10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude pos Pr | ☑ | −10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude neg Y | ☑ | −10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude neg Pb | ☑ | −10.00 | 10.00 | dB | Sin x/x [408 FF] |

Absolute Amplitude Unit: mV

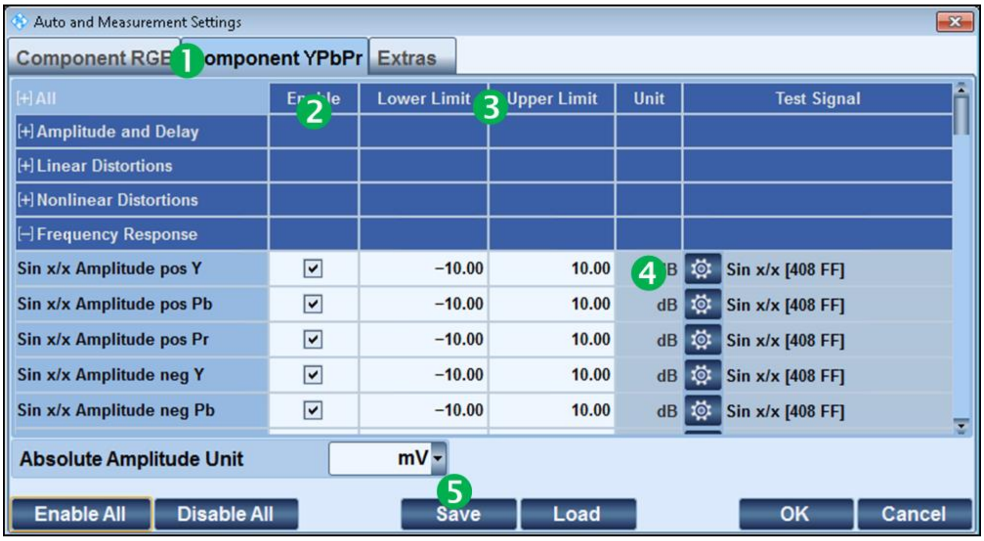
**Fig. 6-5: Opening the "Auto and Measurement Settings" dialog box in the "Auto" view.**

You can set the following in the "Auto and Measurement Settings" dialog box:

- Measurements to be performed
- Limit values for indicating violations
- Via a further dialog box for each measurement ⚙
- Location of the test lines

- Type of test signal
- Test locations within a test line
- Options to save and load configurations
- Option to define a separator character when saving test logs

Follow these steps to perform a complete configuration:



| [+] All | Enable | Lower Limit | Upper Limit | Unit | Test Signal |
|---|---|---|---|---|---|
| [+] Amplitude and Delay | | | | | |
| [+] Linear Distortions | | | | | |
| [+] Nonlinear Distortions | | | | | |
| [–] Frequency Response | | | | | |
| Sin x/x Amplitude pos Y | ☑ | –10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude pos Pb | ☑ | –10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude pos Pr | ☑ | –10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude neg Y | ☑ | –10.00 | 10.00 | dB | Sin x/x [408 FF] |
| Sin x/x Amplitude neg Pb | ☑ | –10.00 | 10.00 | dB | Sin x/x [408 FF] |

Absolute Amplitude Unit: mV

**Fig. 6-6: "Auto and Measurement Settings" dialog box.**

7. In the upper area of the **Component RGB** or **Component YBbPr** tab, select the color space being configured. The color space selected on the Input tab (see Fig. 6-2: Video analyzer input view.) is automatically set as the default. The tabs available in this view are used to configure the defined signal input. If other tabs are present – e.g. "PAL" with "NTSC" or "Component RGB" with "Composite YCbCr" – close the dialog box and set the signal input to "Component".
8. The signal inputs "Component" – for analog video components – and "HDMI" or "MHL" – for digital video components – use the same configuration. This means that a configuration defined for analog interfaces can immediately be used on digital signals as well. This is especially useful for set-top boxes because the same signal content is often output over both analog and digital interfaces.
9. In the **Enable** column, select the measurements to be performed. Use the **Enable All** or **Disable All** button to enable all measurements or disable all measurements. Please note that the number of enabled measurements will affect the time required for the measurement. Therefore, you should enable only those measurements that are actually needed.
10. In the **Lower Limit** and **Upper Limit** columns, configure the desired limit values. In the **Absolute Amplitude Unit** field, select whether the limit values for the absolute measurements will be entered in mV or as a % in relation to the nominal amplitude. The setting in this field may make it easier to provide the right limit value. It does not change how the measured value is displayed. The results of absolute measurements are always output in mV.

11. If necessary, the dialog box for configuring the individual measurements can be opened. Here, you can set the test signal to be used, adjust the line position setting, and adjust the test locations for the partial measurements. This dialog box also shows the video signal in the selected test line. This makes it possible to check whether the configuration actually matches the current signal. For details, see section 6.3.
12. If appropriate, click the **Save** button to save the configuration. Only the settings for the currently selected color format are saved. This makes it possible to save individual measurement configurations for video analysis and to reload them independently of other instrument settings. Alternatively, you can also save and reload the entire instrument configuration. To do this, click the Save icon in the toolbar.

To adjust to country-specific conditions, go to the **Extras** tab to define the character to be used for the decimal point when saving measurement logs. You can choose between a comma and a period. These settings apply to all video standards and signal inputs.

Once all configurations are complete, click the **OK** button to close the dialog box.

## 6.3 Configuring the Test Parameters

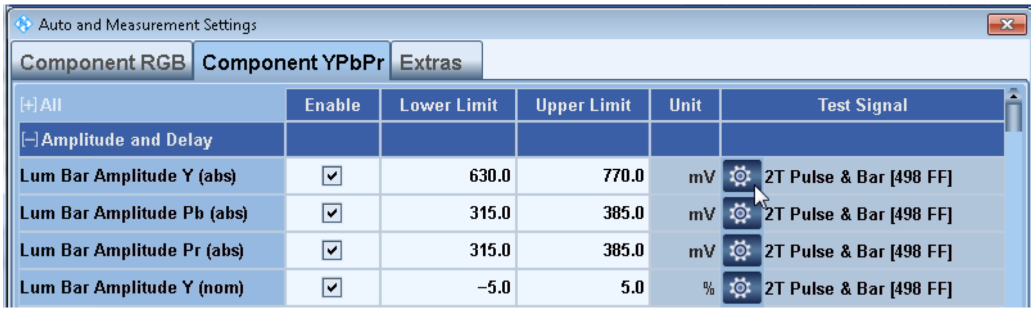
Video analysis is preconfigured for all standards based on the Rohde & Schwarz combined test pattern. For details on the test signals, refer to Appendix A. If the configuration is in an undefined state, you can restore the default settings by clicking the Reset button in the toolbar.

This section describes how to adjust the configuration to analyze other test signals or patterns with different test line positions. This task is especially easy with the R&S®VTC/VTE/VTS/BTC video analyzer because it sets the video signal format automatically and adjusts the configuration accordingly.

However, you must take the following into consideration for configuring the test line position and the position of the test points within the test lines:

- The configuration is always based on the format of the current video signal.
- If no video signal is present, the last valid format is used.
- If no signal has been present since the instrument was powered on, the configuration will be based on the 720 x 576 p video format.
- If the format changes after the configuration, the test line position and the position of the test points are automatically adjusted to the new format. Because rounding errors can occur, it is useful to use test patterns that have identical test lines over several lines.
- The position of the white pulse’s rising slope has a dual significance. It also serves as time reference for the position of the test locations of all other measurements (see section 7.6.5.1).

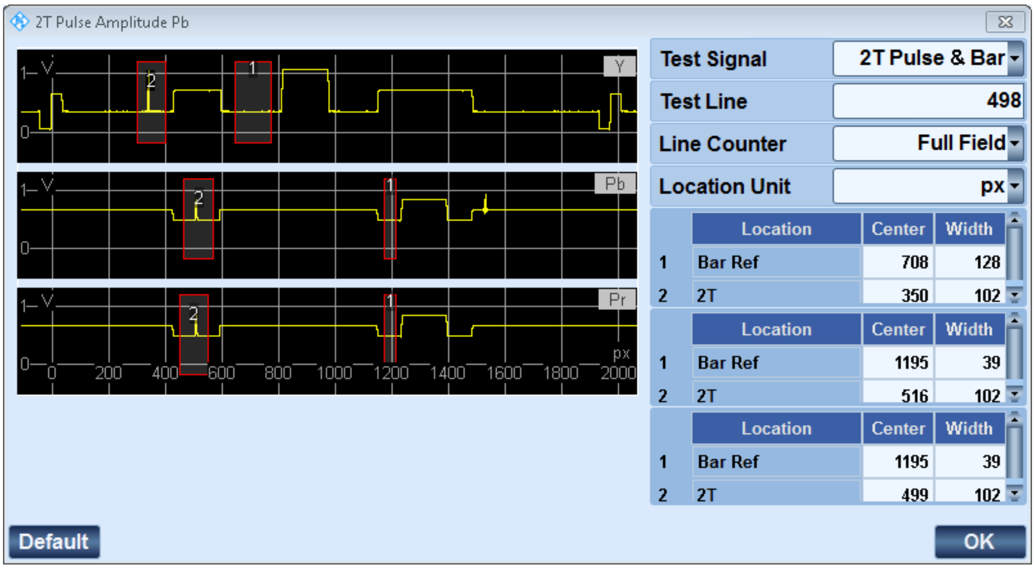
As described in section 6.2, to configure the measurement, click the appropriate buttons to the left, next to the specification of the test signal and the test line position.



| [+] All | Enable | Lower Limit | Upper Limit | Unit | Test Signal |
|---|---|---|---|---|---|
| [–] Amplitude and Delay | | | | | |
| Lum Bar Amplitude Y (abs) | ☑ | 630.0 | 770.0 | mV | 2T Pulse & Bar [498 FF] |
| Lum Bar Amplitude Pb (abs) | ☑ | 315.0 | 385.0 | mV | 2T Pulse & Bar [498 FF] |
| Lum Bar Amplitude Pr (abs) | ☑ | 315.0 | 385.0 | mV | 2T Pulse & Bar [498 FF] |
| Lum Bar Amplitude Y (nom) | ☑ | −5.0 | 5.0 | % | 2T Pulse & Bar [498 FF] |

**Fig. 6-7: Opening the dialog box for setting the test signal, test line position and test point positions.**

The basic layout of the dialog box is the same for all measurements. The only difference is the number and type of measurement windows. The following section describes the user controls based on an example configuration for the 2T pulse amplitude.



Test Signal: 2T Pulse & Bar
Test Line: 498
Line Counter: Full Field
Location Unit: px

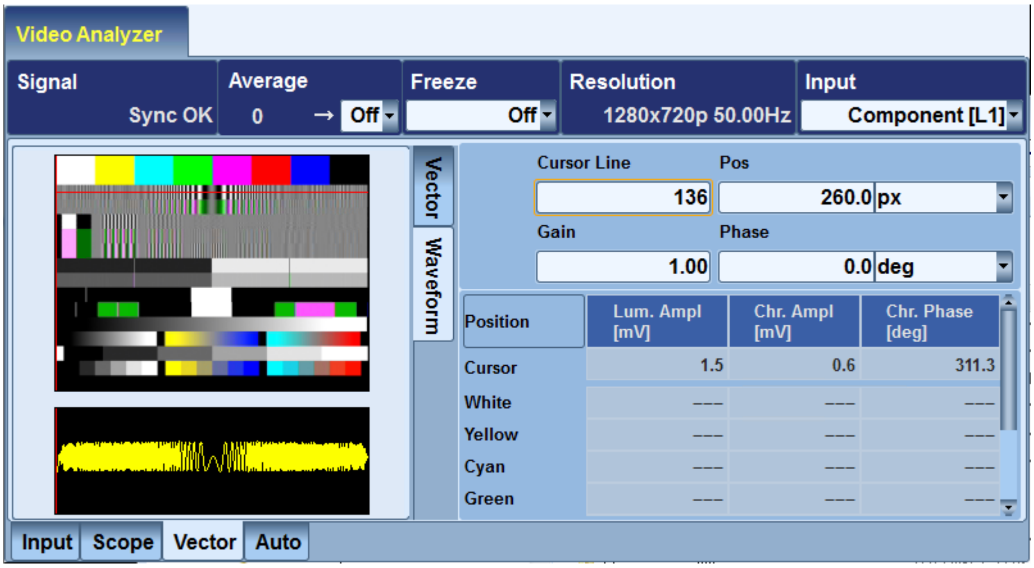
| | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Ref | 708 | 128 |
| 2 | 2T | 350 | 102 |

| | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Ref | 1195 | 39 |
| 2 | 2T | 516 | 102 |

| | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Ref | 1195 | 39 |
| 2 | 2T | 499 | 102 |

**Fig. 6-8: Dialog box for configuring the 2T pulse amplitude.**

- **Test Signal** – Select the test signal to be used to capture the measured value. Appendix B shows the mapping of test signals to the different measurements.
- **Test Line** – Select the line in the video signal that contains the selected test signal. The available line range is based on the current video signal. If it is not known which video line is transmitting the required test signal, the easiest way to find it is to use the vector view. As shown in Fig. 6-9, the video content is displayed along with the waveform of the video line marked with the cursor line. The value of the cursor line corresponds to the full-field line counter.



Signal: Sync OK
Average: 0 → Off
Freeze: Off
Resolution: 1280x720p 50.00Hz
Input: Component [L1]
Cursor Line: 136
Pos: 260.0 px
Gain: 1.00
Phase: 0.0 deg

| Position | Lum. Ampl [mV] | Chr. Ampl [mV] | Chr. Phase [deg] |
|---|---|---|---|
| Cursor | 1.5 | 0.6 | 311.3 |
| White | --- | --- | --- |
| Yellow | --- | --- | --- |
| Cyan | --- | --- | --- |
| Green | --- | --- | --- |

**Fig. 6-9: Vector view for finding test lines.**

- **Line Counter** – Set how the video lines are counted. This setting is used only for entering the line number. In the measurement log, the line numbers always are referenced to the full field. The following settings are available:
- Full Field – Lines including the blanking interval
- Active Field – Only active video lines
  In the case of interlaced signals, 1 indicates the first active line in the first field and the largest number indicates the last active line in the second field
- %VAct – Like for Active Field, but defined as a % (0 % corresponds to the first line and 100 % to the final line in full field). This is also valid for interlaced signals
- **Location Unit** – Unit used to specify the temporal positions of the test locations and the widths of the measurement windows. The following settings are available:
- µs – Input in µs referenced to the start of the video line. 0 µs indicates the first slope of the horizontal sync pulse in this line
- px – Input in pixels referenced to the start of the active range in the video line
- Location **Center** and **Width** – Position of the individual partial measurements and the width of the measurement window. The definition of the measurement window depends on the type of measurement. Available options are:
- Level measurement (see window 1 in Fig. 6-10)
  The measurement window shows the range within which all level values are averaged. The longer the measurement window, the less sensitive the measurement is to noise. The signal level should remain on a constant level within the measurement window
- Pulse measurement (see window 2 in Fig. 6-10)
  The measurement window describes the range in which the analysis searches for the pulse to be analyzed. The measurement window must not include any other signal elements than this pulse

- Slope measurement (see windows 1 and 2 in Fig. 6-11)
  The measurement window describes the position of the slope to be analyzed. The start and the end of the measurement window determine where the analysis captures the 0 % and the 100 % level for determining the 50 % value of the level transition. The measurement window must not include any other signal elements than this slope

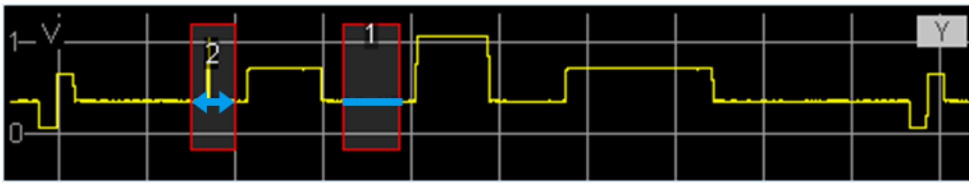


**Fig. 6-10: Example of "2T Pulse Amplitude": Measurement window 1 defines the range used to capture the black value reference level and measurement window 2 defines the position of the 2T pulse.**

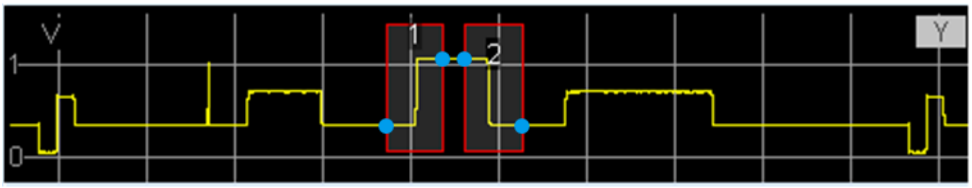
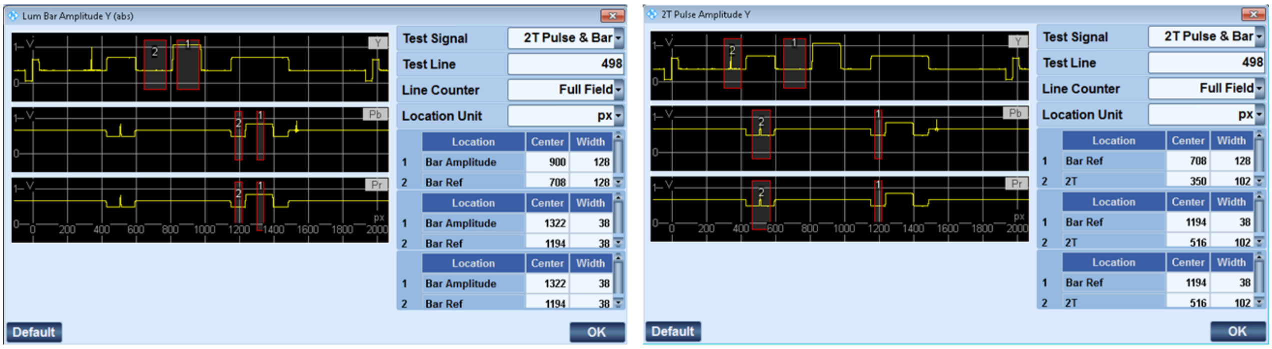


**Fig. 6-11: Example of "Lum Bar Duration": Measurement windows 1 and 2 define the position of the rising and falling slopes of the white pulse.**

- The **Default** button restores the default settings as optimized for the Rohde & Schwarz combined test pattern measurement.

Several measurements use the same test signal (see Appendix B). The assigned line number for this test signal then also applies to all these measurements. The same goes for test points within the test signal that are used more than once. An example of this is shown in Fig. 6-12, based on the settings for the luminance bar amplitude and 2T amplitude measurements.



Lum Bar Amplitude Y (abs)

Test Signal: 2T Pulse & Bar
Test Line: 498
Line Counter: Full Field
Location Unit: px

|  | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Amplitude | 900 | 128 |
| 2 | Bar Ref | 708 | 128 |

|  | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Amplitude | 1322 | 38 |
| 2 | Bar Ref | 1194 | 38 |

|  | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Amplitude | 1322 | 38 |
| 2 | Bar Ref | 1194 | 38 |

2T Pulse Amplitude Y

Test Signal: 2T Pulse & Bar
Test Line: 498
Line Counter: Full Field
Location Unit: px

|  | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Ref | 708 | 128 |
| 2 | 2T | 350 | 102 |

|  | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Ref | 1194 | 38 |
| 2 | 2T | 516 | 102 |

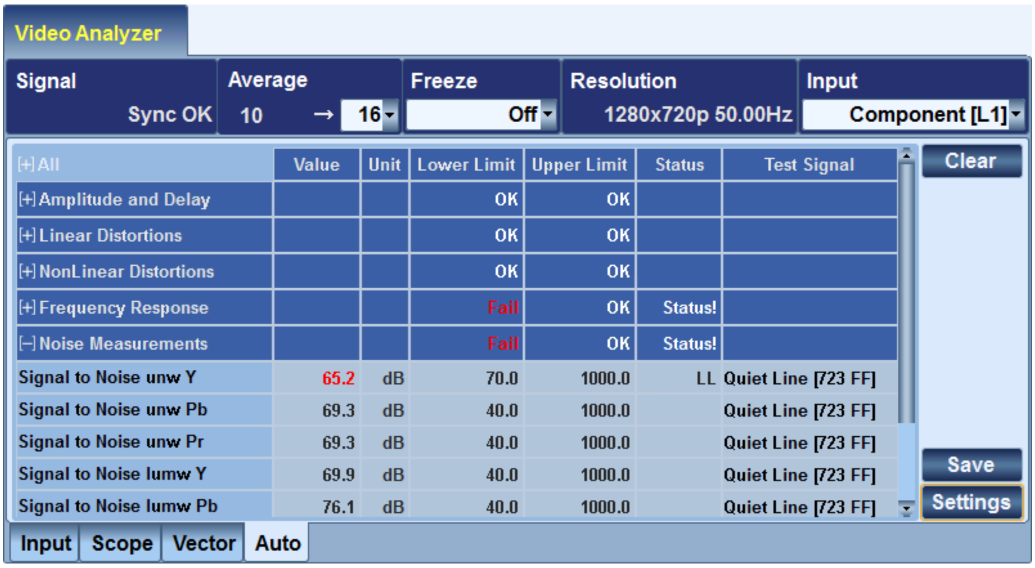
|  | Location | Center | Width |
|---|---|---|---|
| 1 | Bar Ref | 1194 | 38 |
| 2 | 2T | 516 | 102 |

**Fig. 6-12: Dialog boxes for configuring the luminance bar amplitude and 2T pulse amplitude measurements on the 2T Pulse & Bar test signal.**

The settings shown in Fig. 6-12 are used to measure the "luminance bar amplitude" and the "2T amplitude" on the **2T Pulse & Bar** test signal. Both measurements use the same settings for **Test Line** and **Bar Ref**. This means that a change in the settings for one measurement will automatically be used for the other measurement. On the other hand, the test position settings for **Bar Amplitude** and **2T** are assigned to the specific individual measurements and are used only there.

## 6.4 Performing the Measurement

The video analyzer measurement starts automatically. For an improved overview, the measurement results are grouped into categories. The group labels include the overall status of all included measurement results. For example, a red "Fail" for a group indicates that at least one measurement in this group violates its limit value. This permits a quick overview of the quality of the current video signal.



Signal: Sync OK
Average: 10 → 16
Freeze: Off
Resolution: 1280x720p 50.00Hz
Input: Component [L1]

| [+]All | Value | Unit | Lower Limit | Upper Limit | Status | Test Signal |
|---|---|---|---|---|---|---|
| [+]Amplitude and Delay | | | OK | OK | | |
| [+]Linear Distortions | | | OK | OK | | |
| [+]NonLinear Distortions | | | OK | OK | | |
| [+]Frequency Response | | | Fail | OK | Status! | |
| [−]Noise Measurements | | | Fail | OK | Status! | |
| Signal to Noise unw Y | 65.2 | dB | 70.0 | 1000.0 | LL | Quiet Line [723 FF] |
| Signal to Noise unw Pb | 69.3 | dB | 40.0 | 1000.0 | | Quiet Line [723 FF] |
| Signal to Noise unw Pr | 69.3 | dB | 40.0 | 1000.0 | | Quiet Line [723 FF] |
| Signal to Noise lumw Y | 69.9 | dB | 40.0 | 1000.0 | | Quiet Line [723 FF] |
| Signal to Noise lumw Pb | 76.1 | dB | 40.0 | 1000.0 | | Quiet Line [723 FF] |

**Fig. 6-13: Display of measured values in the video analyzer.**

The individual columns of the measured value display include the following information:

- **Value** – Measured value.
  Measured values in red indicate that this measurement violated one of the limit values.
- **Unit** – Unit for the measured value
- **Lower** limit and upper limit
- **Status** – Additional information if no measured value is displayed or if a limit value was violated.
  Available options are:
- Signal? – No video signal is available or the current signal cannot be synchronized.

- Wait – Measurement not yet complete
- Test Signal? – The test signal in the test line does not match the measurement.
- LL – The lower limit value was violated
- UL – The upper limit value was violated
- **Test Signal** – Test signal and line to be measured.
  The line number is always specified in reference to the full field video signal.

To control the measurement, the following user controls are available:

**Average** is used to define the number of averaged measured values. This permits stable and reproducible measurement results even for noisy signals. The **Clear** button is used to clear all previous measurements. The **Save** button is used to open a dialog box for saving the measured results in csv (comma-separated values) format.

The **Settings** button opens a dialog box to configure the video analysis (see section 6.2).

An example of a typical measurement log is provided in Appendix C .

# 7 Automated Measurements

Automated measurements for video component signals can be categorized as follows:

- Amplitude and delay
- Linear distortions
- Nonlinear distortions
- Frequency response
- Noise
- Timing
- Jitter

This section describes the individual measurements. It includes a definition of the measurements, the effects of any deviations and a description of the required test signals.

For each measurement, the test signal is shown – at the top as it is seen on a monitor and, below that, as a time signal as displayed on an oscilloscope.

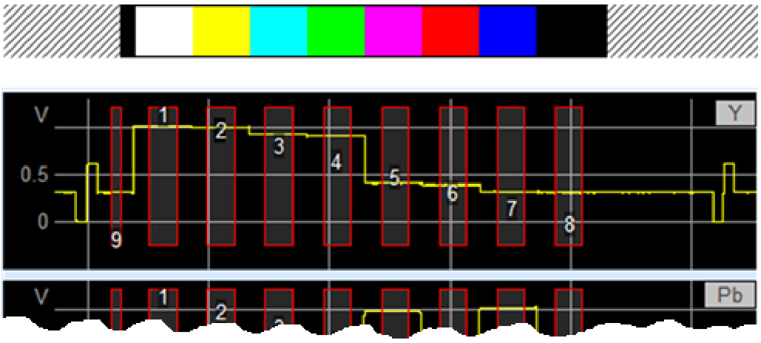


**Fig. 7-1: Display of the test signal and the test locations using the color bar as an example.**

Markings in the time signal show which elements of the test signal are used for the evaluation. The position of the markings can be adjusted at any time if necessary (see section 6.3).

Unless specified otherwise, all definitions apply to all three video components.

## 7.1 Amplitude and Delay

This category of measurements captures deviations in the signal level and the relative delay for the three component signals. Level errors can affect the results of other measurements. For that reason alone, a measurement of the level values should be part of every test protocol.

## 7.1.1 Luminance Bar Amplitude

### 7.1.1.1 Definition

The **Luminance Bar Amplitude** specifies the largest signal amplitude in the visible picture. If it is too small, the picture will be too dark and the dynamic range will not be fully utilized. If it is too large, the danger of overdrive exists.

The measured value is calculated from the delta between the level in the white range and the level in the black range. The result is expressed as a % referenced to a nominal value of 700 mV or as an absolute value in mV.

The test signal is a test line with a white pulse as contained in the "T2 Pulse & Bar" test line.

### 7.1.1.2 Test Locations

| Test locations | | |
|---|---|---|
| 1 | Bar Amplitude | Level in white range |
| 2 | Bar Ref | Level in black range |

**Table 7-1: Test locations for the luminance bar amplitude measurement.**

### 7.1.1.3 YPbPr Test Signal

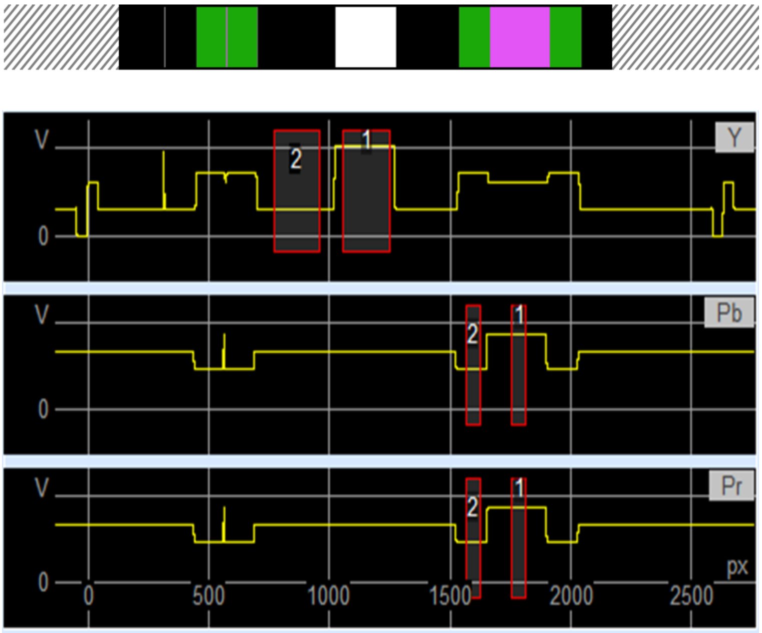


**Fig. 7-2: Measuring the luminance bar amplitude on YPbPr "2T Pulse & Bar" test signal.**

For the YPbPr signal, the test locations in the three video component signals can be set independently of one another.

#### 7.1.1.4 GBR Test Signal

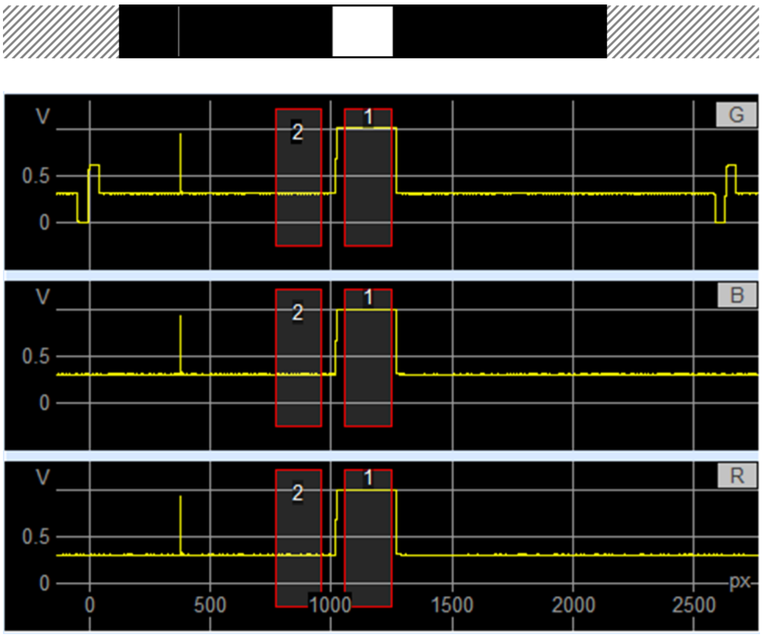


**Fig. 7-3: Measuring the luminance bar amplitude on YPbPr "2T Pulse & Bar" test signal.**

For the GBR signal, the test location is the same for all three components.

### 7.1.2 Sync Pulse Amplitude

#### 7.1.2.1 Definition

The **Sync Amplitude** measurement records the amplitudes of the sync pulses contained in the Y channel or the G channel.

If the sync pulses are too small, receivers cannot synchronize reliably. If the sync pulses are too large, the dynamic range of the signal will be reduced.

Depending on the video resolution, the sync pulse will be either bi-level or tri-level (see Appendix A.3). The R&S®VTC/VTE/VTS/BTC video analyzer takes this into consideration automatically. In the case of a tri-level sync, the measured value is calculated from the difference between the tri-level high and low levels. For a bi-level sync, the difference between the black value and the base sync is measured.

The result is expressed as a % referenced to the nominal value or as an absolute voltage value in mV.

The measurement can use any video lines in the active picture area or in the vertical blanking interval (VBI).

### 7.1.2.2 Test Locations

| **Test locations** | | |
|---|---|---|
| **Tri-level sync** | | |
| 1 | Sync Tri-Level Low | Level at the negative peak for the sync pulse |
| 2 | Sync Tri-Level High | Level at the positive peak for the sync pulse |
| **Bi-level sync** | | |
| 1 | Sync Ampl | Level at the sync pulse base |
| 2 | Sync Ref | Level in the black range |

**Table 7-2: Test locations for the sync pulse amplitude measurement.**

### 7.1.2.3 YPbPr Test Signal

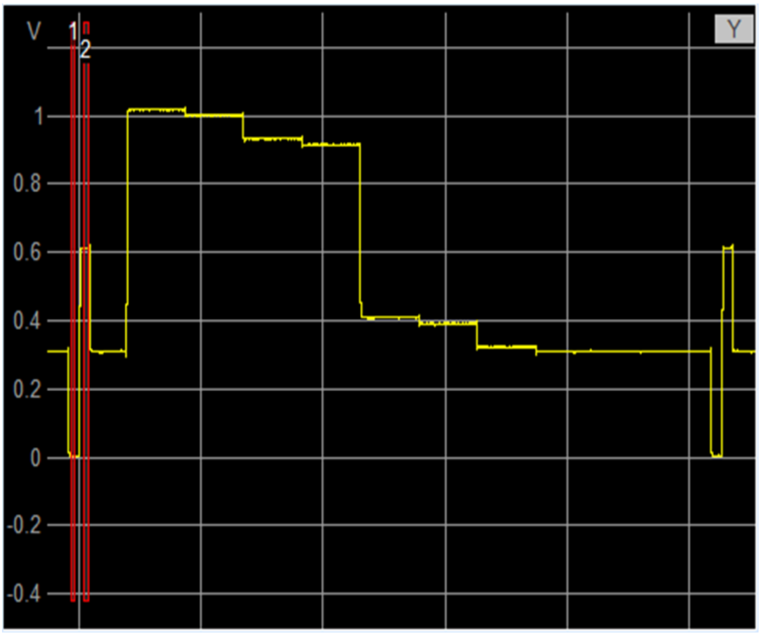


**Fig. 7-4: Measuring the sync pulse amplitude on a YPbPr video line with tri-level sync pulse.**

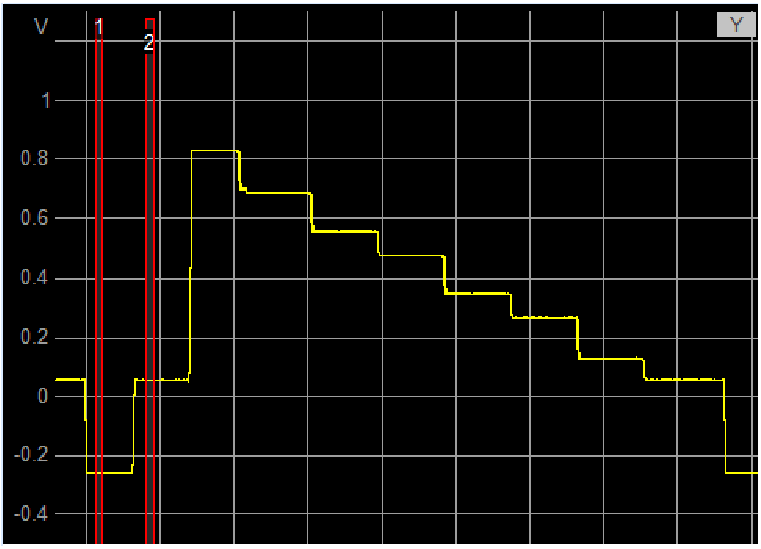


Fig. 7-5: Measuring the sync pulse amplitude on a YPbPr video line with bi-level sync pulse.

### 7.1.2.4 GBR Test Signal

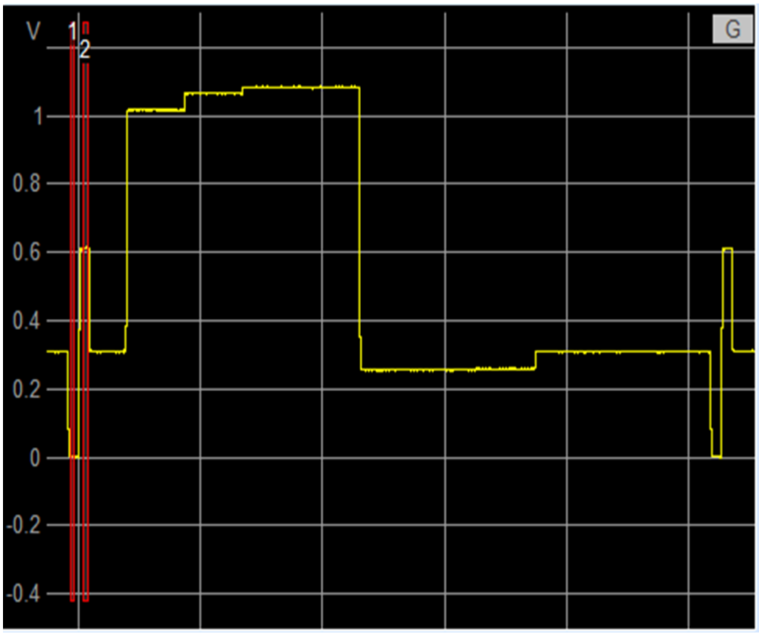


Fig. 7-6: Measuring the sync pulse amplitude on a GBR video line with tri-level sync pulse.

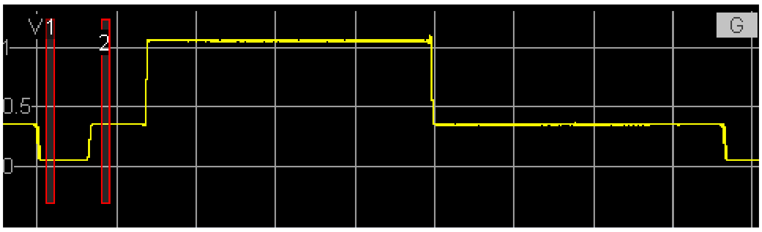


Fig. 7-7: Measuring the sync pulse amplitude on a GBR video line with bi-level sync pulse.

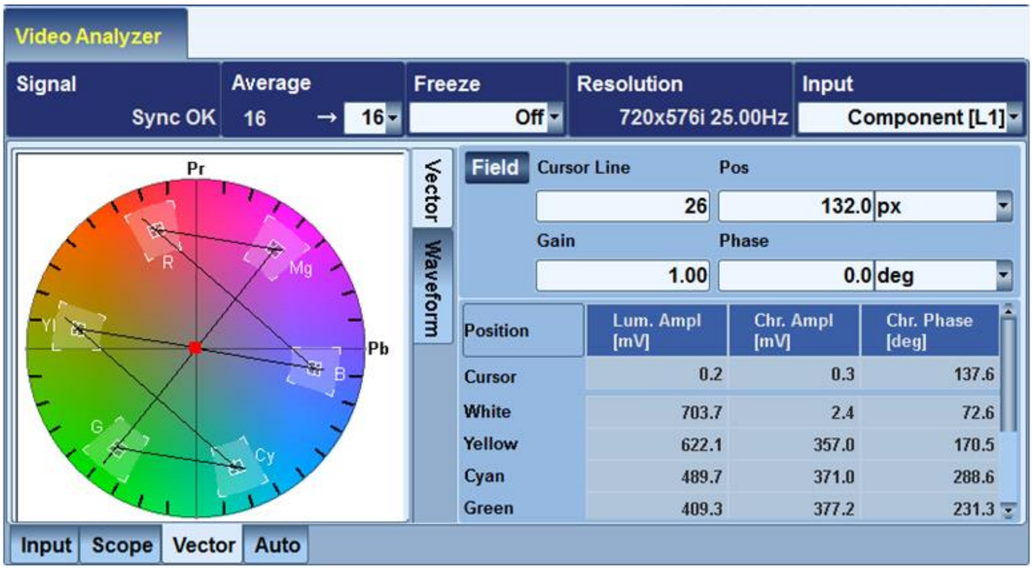
## 7.1.3 Color Bar Amplitude

### 7.1.3.1 Definition

The **Color Bar Amplitude** measurements capture all level values for the individual colors of the normal color bar.

Deviations from the reference value are visible as color deviations in the picture.

This measurement is comparable to an analysis using a vectorscope, except that on a vectorscope, the level values of the individual video component signals are converted into color amplitude and phase angle. The resulting picture shows the immediate effect of level deviations on the color reproduction.



Signal: Sync OK
Average: 16 → 16
Freeze: Off
Resolution: 720x576i 25.00Hz
Input: Component [L1]

Cursor Line: 26
Pos: 132.0 px
Gain: 1.00
Phase: 0.0 deg

| Position | Lum. Ampl [mV] | Chr. Ampl [mV] | Chr. Phase [deg] |
|---|---|---|---|
| Cursor | 0.2 | 0.3 | 137.6 |
| White | 703.7 | 2.4 | 72.6 |
| Yellow | 622.1 | 357.0 | 170.5 |
| Cyan | 489.7 | 371.0 | 288.6 |
| Green | 409.3 | 377.2 | 231.3 |

**Fig. 7-8: Measuring the color bar using a vectorscope.**

In contrast, the auto measurement assesses the level values directly, without any conversions. This makes it easier to attribute deviations to the individual color components. The black value in each line serves as the reference for all values in that line. The result is expressed as an absolute voltage value in mV.

The test signal is a color bar with 100 % modulation.

### 7.1.3.2 Test Locations

| **Test locations** | | |
|---|---|---|
| 1 | White Bar | Amplitude white bar |
| 2 | Yellow Bar | Amplitude yellow bar |
| 3 | Cyan Bar | Amplitude cyan bar |
| 4 | Green Bar | Amplitude green bar |
| 5 | Magenta Bar | Amplitude magenta bar |
| 6 | Red Bar | Amplitude red bar |
| 7 | Blue Bar | Amplitude blue bar |
| 8 | Black Bar | Amplitude black bar |
| 9 | Black Reference | Black reference for all amplitude measurements |

**Table 7-3: Test locations for the color bar amplitude measurement.**

### 7.1.3.3 YPbPr Test Signal

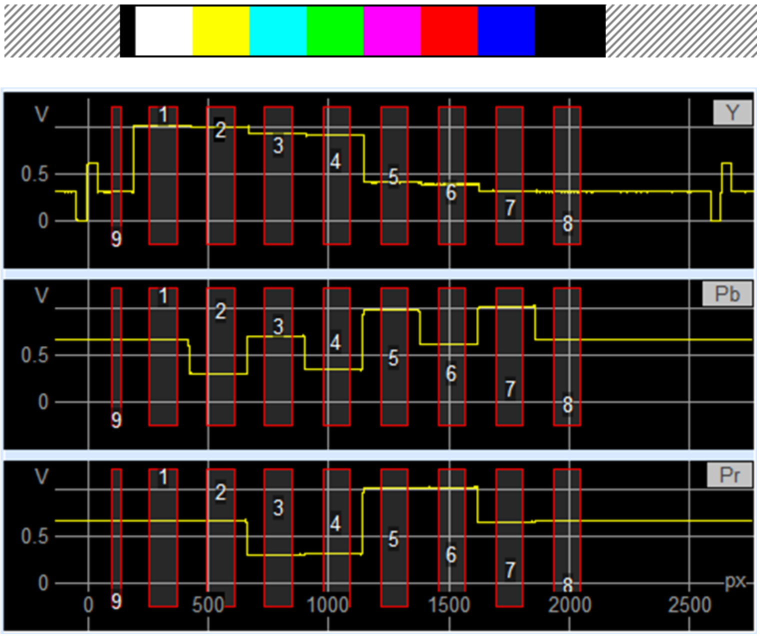


**Fig. 7-9: Measuring the color bar amplitudes on the YPbPr "Color Bars" test signal.**

### 7.1.3.4 GBR Test Signal

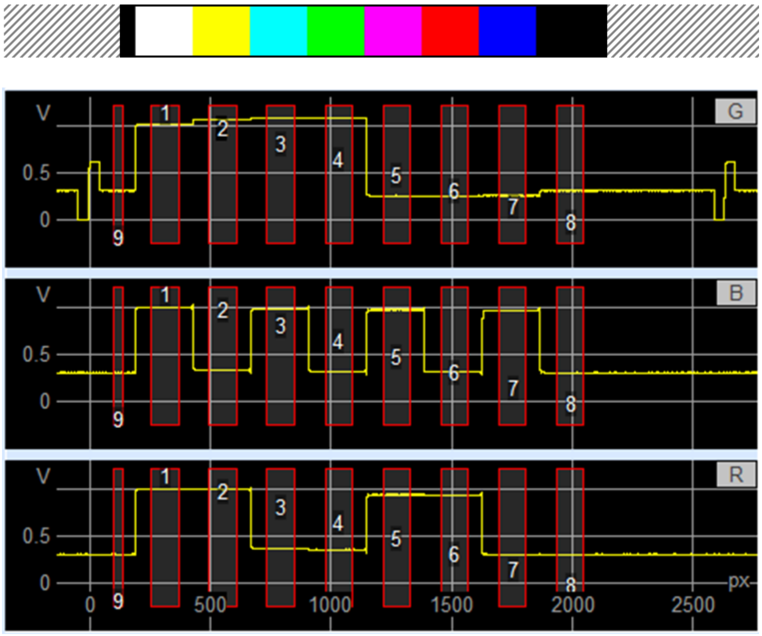


**Fig. 7-10: Measuring the color bar amplitudes on the GBR "Color Bars" test signal.**

## 7.1.4 Inter Channel Amplitude

### 7.1.4.1 Definition

The **Inter Channel Amplitude** measurement captures the level differences among the individual components. Deviations from the reference values result in color deviations in the picture.

The following table shows which color components are compared.

| **Inter channel amplitude measurements** | |
|---|---|
| **Color system YPbPr** | |
| Inter Channel Ampl. (Y – Pb) | Amplitude of the Y component referenced to color difference component Pb |
| Inter Channel Ampl. (Y – Pr) | Amplitude of the Y component referenced to color difference component Pr |
| Inter Channel Ampl. Pb – Pr) | Amplitude of color difference component Pb referenced to color difference component Pr |
| **Color system GBR** | |
| Inter Channel Ampl. (G – B) | Amplitude of the green component referenced to the blue component |
| Inter Channel Ampl. (G – R) | Amplitude of the green component referenced to the red component |
| Inter Channel Ampl. (B – R) | Amplitude of the blue component referenced to the red component |

**Table 7-4: Inter channel amplitude measurements.**

The result is expressed in % as a relative deviation. As an example: The test result “Inter Channel Ampl. (Y - Pb) = -10%” means, that the level of the Y component is 10 % smaller than the level of the Pb component.

The measurement is taken on the color bar signal. The transition from green to magenta is used for the comparison of the level differences. This transition represents the greatest difference over all components and is therefore the least sensitive to noise.

### 7.1.4.2 Test Locations

| Test location | | |
|---|---|---|
| 1 | Green – Magenta | Transition from green to magenta |

**Table 7-5: Test location for the inter channel amplitude measurement.**

### 7.1.4.3 YPbPr Test Signal

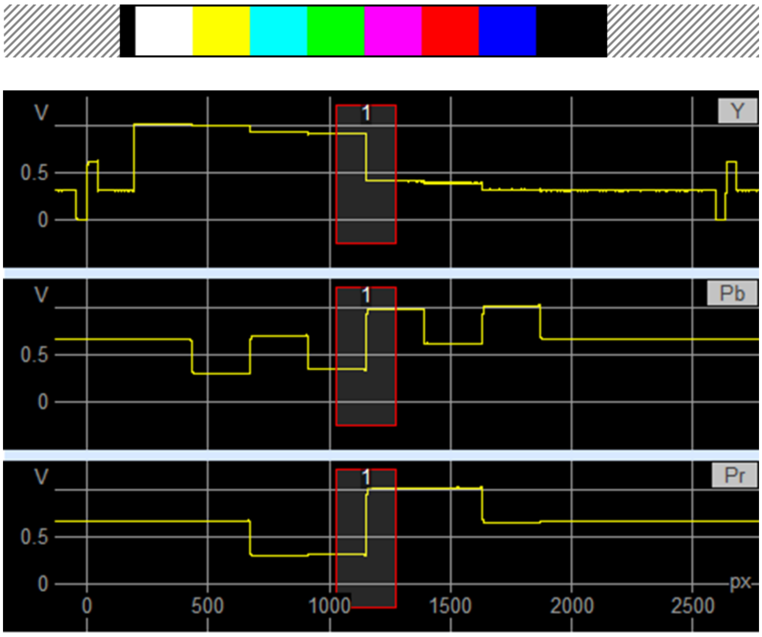


**Fig. 7-11: Measuring the inter channel amplitude on the YPbPr "Color Bar" test signal.**

### 7.1.4.4 GBR Test Signal

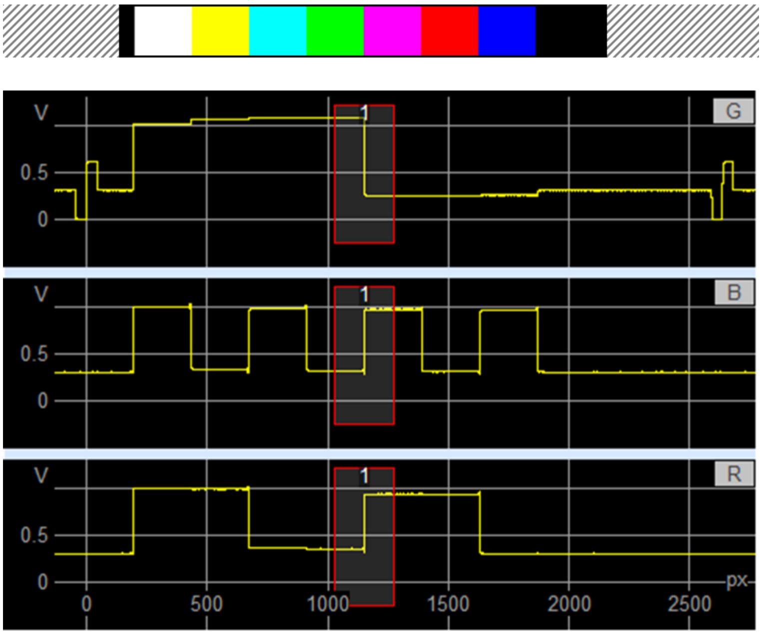


**Fig. 7-12: Measuring the inter channel amplitude on the GBR "Color Bar" test signal.**

## 7.1.5 Inter Channel Delay

### 7.1.5.1 Definition

**Inter Channel Delay** measures the differences in delay for the individual components. Deviations from the reference values result in blurring and color deviations during transitions in brightness.

The following table shows which color components are compared.

| **Inter channel delay measurements** | |
|---|---|
| **Color system YPbPr** | |
| Inter Channel Delay (Y – Pb) | Delays in the Y component as compared with color difference component Pb |
| Inter Channel Delay (Y – Pr) | Delays in the Y component as compared with color difference component Pr |
| Inter Channel Delay Pb – Pr) | Delays in color difference component Pb as compared with color difference component Pr |
| **Color system GBR** | |
| Inter Channel Delay (G – B) | Delays in the green component as compared with the blue component |
| Inter Channel Delay (G – R) | Delays in the green component as compared with the red component |
| Inter Channel Delay (B – R) | Delays in the blue component as compared with the red component |

**Table 7-6: Inter channel delay measurements.**

The delay to each reference component is specified in ns. As an example: The test result “Inter Channel Delay (Y - Pb) = -100 ns” shows that the Y component is 100 ns ahead of the Pb component.

The measurement is taken on the color bar signal at the level transitions from green to magenta. They represent the greatest difference over all components and are therefore the least sensitive to noise.

#### 7.1.5.2 Test Locations

| Test location | | |
|---|---|---|
| 1 | Green – Magenta | Transition from green to magenta |

**Table 7-7: Test location for the inter channel delay measurement.**

#### 7.1.5.3 YPbPr Test Signal

The test signal and settings are identical to that for the inter channel amplitude measurement.
See: Fig. 7-11.

#### 7.1.5.4 GBR Test Signal

The test signal and settings are identical to that for the inter channel amplitude measurement.
See: Fig. 7-12

## 7.2 Linear Distortions

Linear distortions result from deviations in the amplitude and/or phase frequency response.

In contrast to the direct measurement of the frequency response using a multiburst or SINX/X, the following measurements indicate how linear distortions affect the individual signal elements, and thus their visibility.

### 7.2.1 2T Pulse Measurements

#### 7.2.1.1 Definition

The 2T pulse is formed so that it optimally utilizes the transition range of the video signal. As a result, linear distortions directly affect the signal waveform.

All 2T measurements are taken on a 2T pulse as defined in the "T2 Pulse & Bar" test line.

The **2T Pulse Amplitude** measurement captures the percentage of deviation of the 2T amplitude peak as compared with the level of the white pulse. Negative deviations indicate a reduced visibility of fine picture details.

The **2T K Factor** checks the 2T pulse for preshoot and postshoot. These can be caused by group delay distortions, for example. The analysis is performed using a predefined mask. Originally, this mask was defined in the analog video T&M technology for standard definition composite signals.

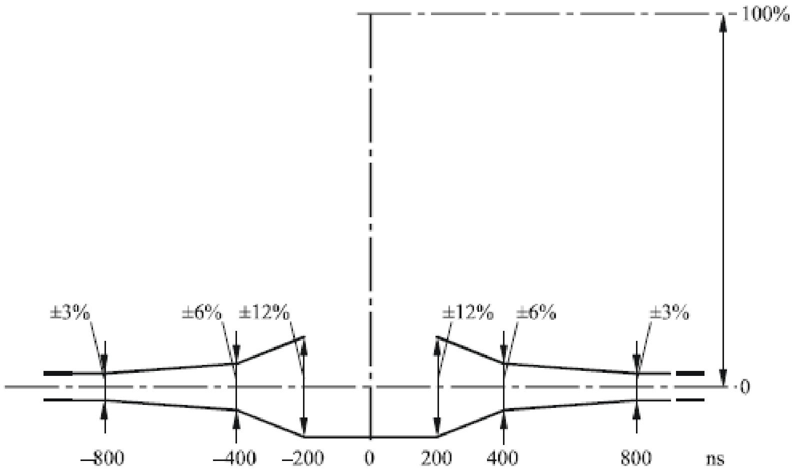


**Fig. 7-13: 3 % 2TK mask for a standard definition video signal with 5 MHz bandwidth and a 2T pulse width of 200 ns.**

However, because the mask references the width of the 2T pulse – and therefore the bandwidth of the video signal – it is possible to convert it for use with other video formats.

The measured value is specified as a %. 0 % indicates that no overshoot is present.

The **2T Pulse HAD** (half amplitude duration) measurement captures the width of the 2T pulse at 50 % of the 2T amplitude. Because the bandwidth of the video signal determines the reference width of the 2T pulse, this measured value must always be considered in conjunction with the resolution of the current video signal (see Appendix A.3).

### 7.2.1.2 Test Locations

| Test locations | | |
|---|---|---|
| 1 | Bar Ref | Reference level. The value is also used as a reference for the measurement of the white pulse amplitude |
| 2 | 2T | 2T pulses |

**Table 7-8: Test locations for the 2T pulse measurements.**

### 7.2.1.3 YPbPr Test Signal

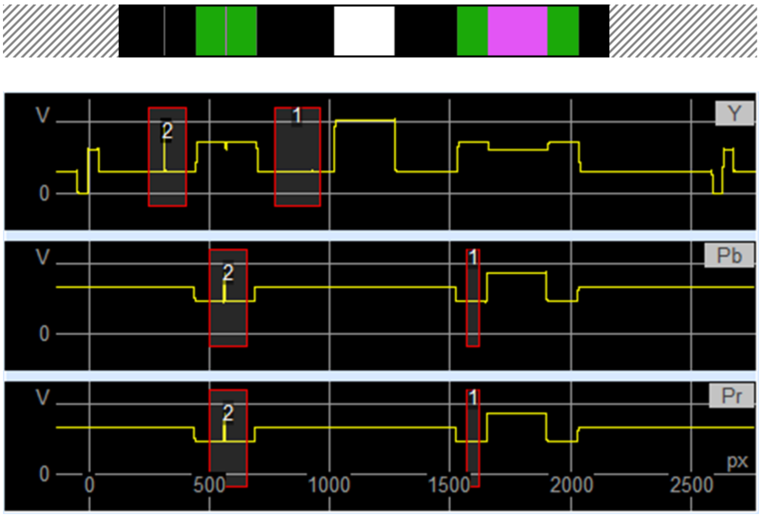


**Fig. 7-14: 2T measurements on the YPbPr "2T Pulse & Bar" test signal.**

For the YPbPr signal, the test locations in the three video component signals can be set independently of one another.

### 7.2.1.4 GBR Test Signal

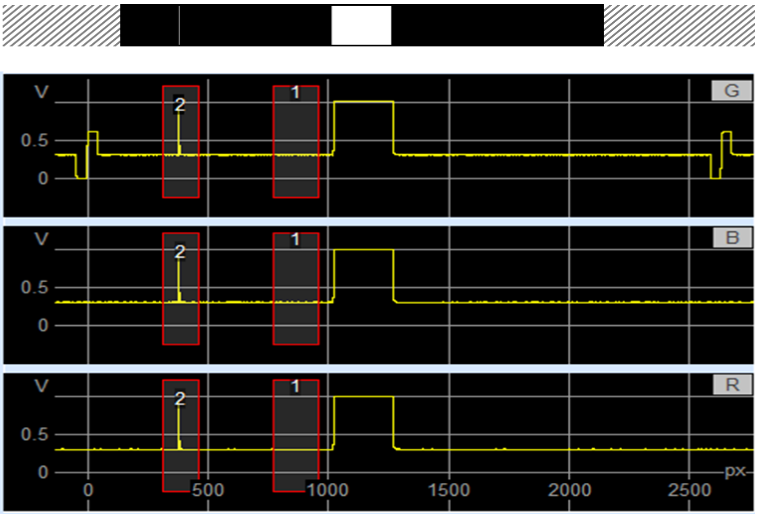


**Fig. 7-15: 2T measurements on the GBR "2T Pulse & Bar" test signal.**

For the GBR signal, the test location is the same for all three video component signals.

## 7.2.2 Short Time Distortion

### 7.2.2.1 Definition

The short time distortion measurement analyzes black-white and white-black transitions. Like for the 2T pulse, the transitions are adapted exactly to the transmission bandwidth of the video signal, and any linear distortions cause deviations in the prescribed signal path. Depending on the type of interference, the picture might be overdrawn or blurred at the level transitions. Color deviations can also occur.

The measurement is taken at the rising and falling slopes of the white pulse as described in the "T2 Pulse & Bar" test line.

The **ST Distortion Rise Time** and **ST Distortion Fall Time** measurements assess the rise and fall times for a white pulse. The nominal value is determined from the signal bandwidth (see Appendix A.3). If the rise times are too short, this indicates an increase in the level frequency response, and rise times that are too long indicate a reduction in the level frequency response. The time is measured in ns.

The **ST Dist Rise Preshoot** and **ST Dist Fall Preshoot** measurements capture the preshoots at the start of the level transitions.

The **ST Dist Rise Overshoot** and **ST Dist Fall Overshoot** measurements capture the overshoots at the end of the level transitions.

The measured values are expressed as a % referenced to the value of the white pulse.

### 7.2.2.2 Test Locations

| Test locations | | |
|---|---|---|
| 1 | Rising Slope | Location of the transition from black to white |
| 2 | Falling Slope | Location of the transition from white to black |

**Table 7-9: Locations for the short time distortion measurements.**

### 7.2.2.3 YPbPr Test Signal

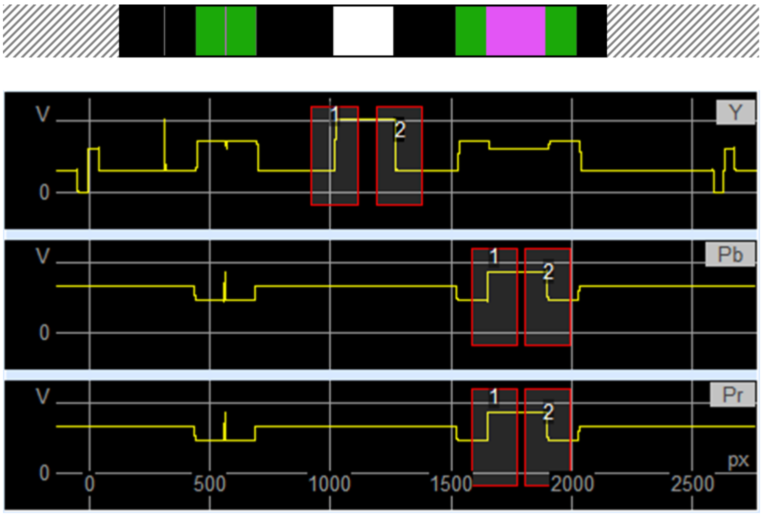


**Fig. 7-16: Short time distortion measurements on the YPbPr "2T Pulse & Bar" test signal.**

For the YPbPr signal, the test locations in the three video component signals can be set independently of one another.

### 7.2.2.4 GBR Test Signal

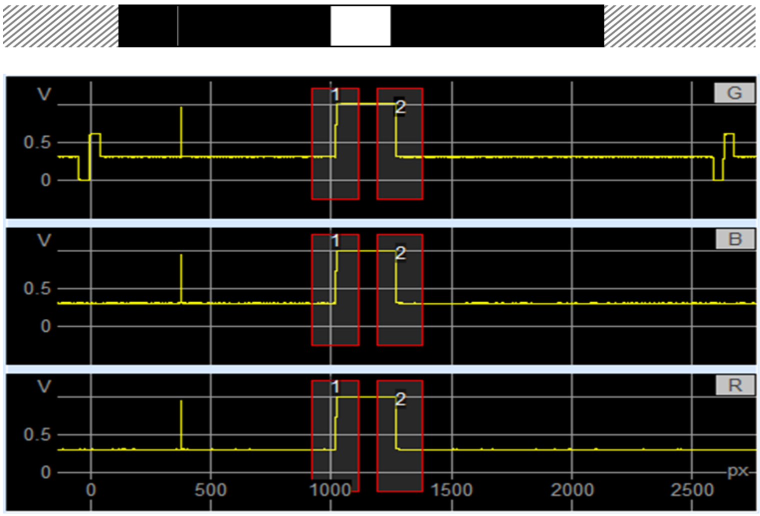


**Fig. 7-17: Short time distortion measurements on the GBR "2T Pulse & Bar" test signal.**

For the GBR signal, the test location is the same for all three video component signals.

## 7.3 Nonlinear Distortions

Curves in the transmission characteristics cause nonlinear distortions and can lead to color deviations.

### 7.3.1 Nonlinearity, Nonlinearity Step 1 to Step 5

#### 7.3.1.1 Definition

This measurement assesses the linearity based on a continuous level increase. The level measurements are taken at regular intervals. For an exactly linear transmission characteristic, the level differences are the same at all adjacent test points. If nonlinear distortions are present, the amplitude values will differ from one another.

The measurement is taken on a step signal or a ramp. It must be ensured that the measurement times are set at regular intervals. If they are not, undistorted signals can cause deviations from the reference value.

The **Nonlinearity** measured value is defined as the difference between the largest and the smallest level difference in relation to the largest level difference. This measured value therefore describes the order of magnitude of the nonlinear distortion.

The values of the individual level differences – **Nonlinearity Step 1** to **Nonlinearity Step 5** – show the progression of the nonlinearity. The measured values are defined as the value of the individual level differences 1 to 5 in relation to the largest level difference.

The measured values are expressed as a %. By definition, the measured value is always positive.

#### 7.3.1.2 Test Locations

| **Test locations** | | |
|---|---|---|
| 1 | Reference | Reference level for the first power level |
| 2 | Step 1 | Level of the first step |
| 3 | Step 2 | Level of the second step |
| 4 | Step 3 | Level of the third step |
| 5 | Step 4 | Level of the fourth step |
| 6 | Step 5 | Level of the fifth step |

**Table 7-10: Test locations for the nonlinearity measurements.**

### 7.3.1.3 YPbPr Test Signal

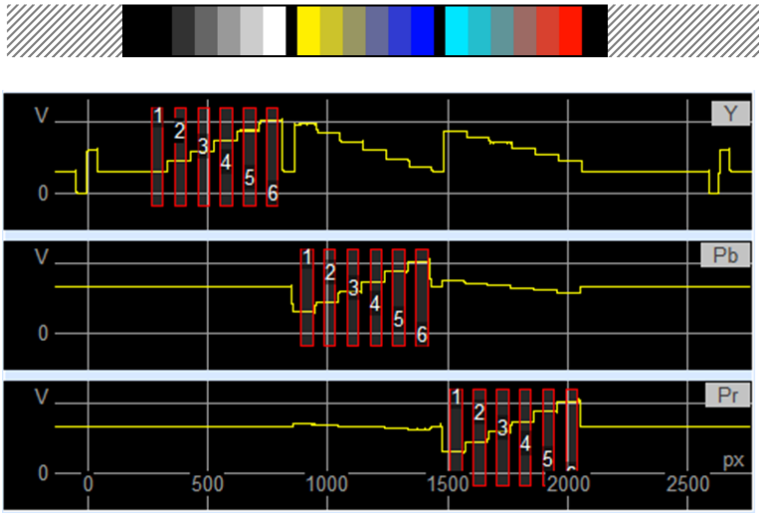


**Fig. 7-18: Nonlinearity measurement on the YPbPr "Staircase" test signal.**

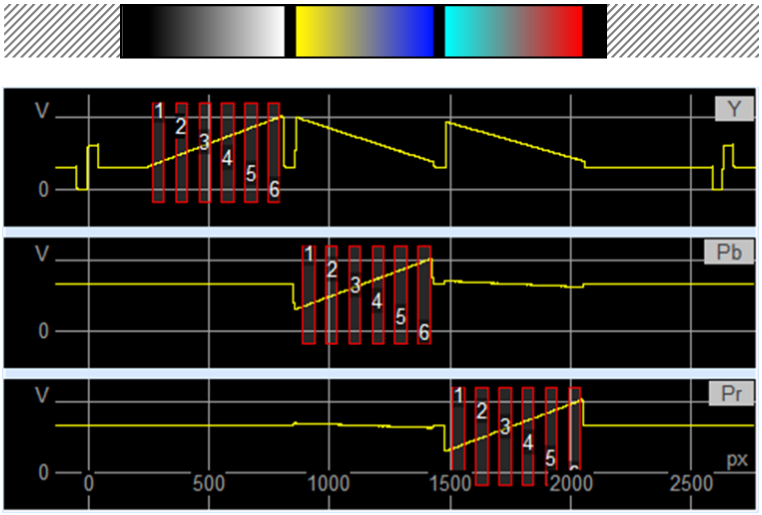


**Fig. 7-19: Nonlinearity measurement on the YPbPr "Ramp" test signal.**

For the YPbPr signal, the test locations in the three video component signals can be set independently of one another.

### 7.3.1.4 GBR Test Signal

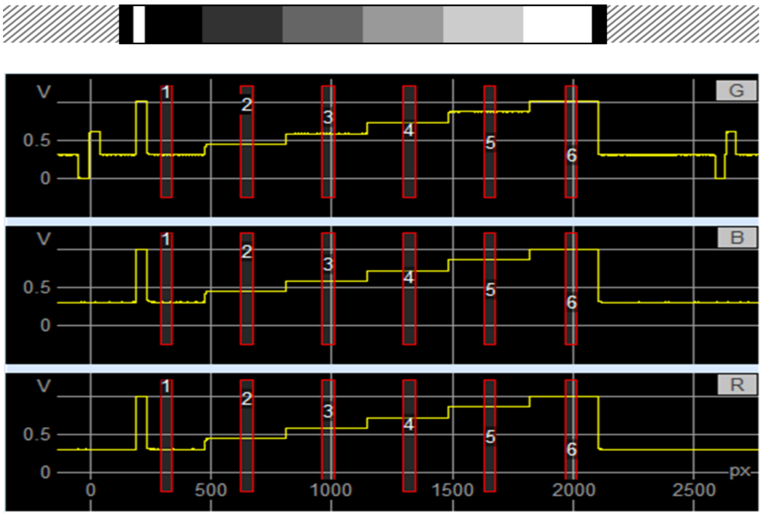


Fig. 7-20: Nonlinearity measurement on the GBR "Staircase" test signal.

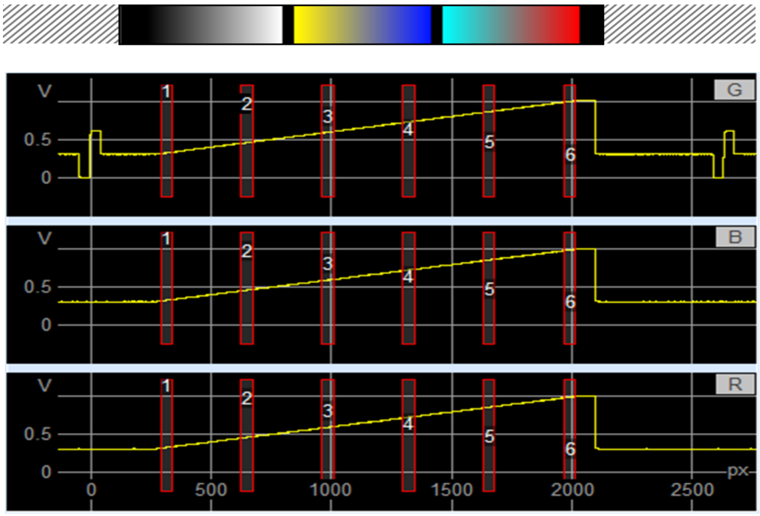


Fig. 7-21: Nonlinearity measurement on the GBR "Ramp" test signal.

## 7.4 Frequency Response

Errors in the frequency domain are also linear distortions. However, in contrast to the linear distortion measurements, these measurements show the frequency response directly.

### 7.4.1 SIN X/X Amplitude, SIN X/X Delay

#### 7.4.1.1 Definition

The spectral composition of the SIN X/X signal covers the entire frequency domain, extending without gaps to the band limit. This makes it possible to analyze the amplitude frequency response as well as the signal delay versus the frequency.

However, the test signal feed must be taken into consideration. In the case of a set-top box, this is typically done via a transport stream, so the test signal must be coded with MPEG-2 or H.264. The associated quantization to 8 bit and the unavoidable code artifacts impair the quality of the test signal. As a result of the lower energy of the SIN X/X test signal, this can lead to strongly varying measurement results.

The measurement is performed via an FFT analysis using a Hanning window. It is almost impossible to analyze the test signal in the time domain using an oscilloscope.

**SIN X/X Amplitude** captures the amplitude frequency response of the signal and **SIN X/X Delay** captures the delay.

The measured values are defined as the largest positive and the largest negative deviation in the frequency range as given in Table 7-11.

| | Frequency range for Y, G, B, R | Frequency range for Pb, Pr | Reference frequency |
|---|---|---|---|
| SDTV 480i/576i 50/60 Hz | 0.3 MHz to 5 MHz | 0.3 MHz to 2.5 MHz | 0.3 MHz |
| SDTV 480p/576p 50/60 Hz | 0.3 MHz to 10 MHz | 0.3 MHz to 5 MHz | 0.3 MHz |
| HDTV 720p/1080i 50/60 Hz | 0.5 MHz to 24 MHz | 0.3 MHz to 12 MHz | 0.5 MHz |
| HDTV 1080p 50/60 Hz | 0.5 MHz to 48 MHz | 0.3 MHz to 24 MHz | 0.5 MHz |

**Table 7-11: Frequency range and reference frequency for SIN X/X measurement.**

#### 7.4.1.2 Test Locations

| **Test locations(** | | |
|---|---|---|
| 1 | Positive | Location of the positive SIN X/X pulse |
| 2 | Negative | Location of the negative SIN X/X pulse |

**Table 7-12: Test locations for the SIN X/X measurements.**

### 7.4.1.3 YPbPr Test Signal

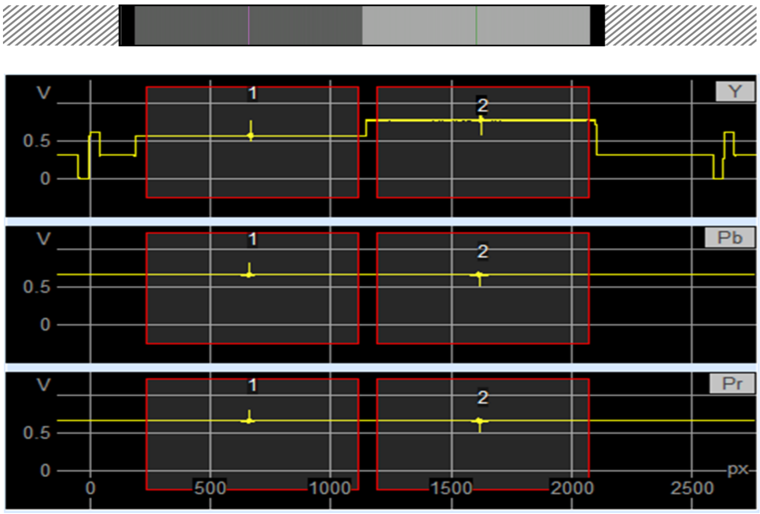


**Fig. 7-22: Measurement of the SIN X/X amplitude and delay on the YPbPr "SIN X/X" test signal.**

### 7.4.1.4 GBR Test Signal

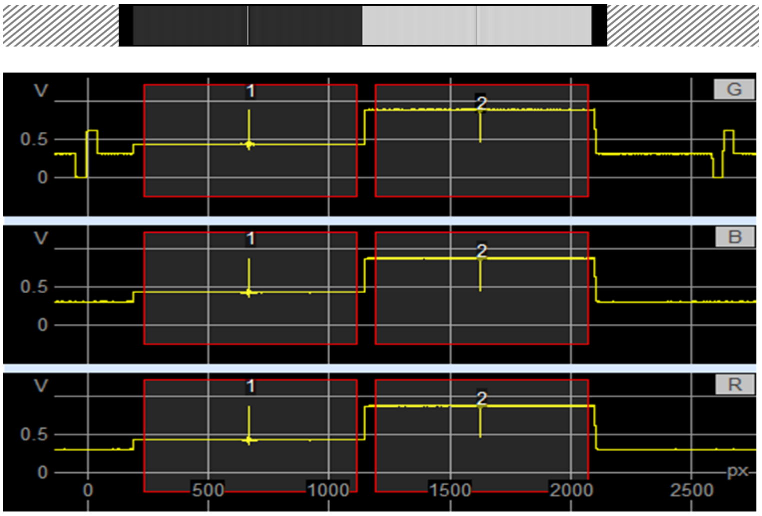


**Fig. 7-23: Measurement of the SIN X/X amplitude and delay on the GBR "SIN X/X" test signal.**

## 7.4.2 Multiburst

### 7.4.2.1 Definition

The multiburst signal contains six sine packets with different frequencies. A multiburst flag pulse serves as the reference.

The high signal level ensures that the signal is significantly less sensitive to disturbances due to quantization, coding and noise superpositions than the SIN X/X signal, for example. It also permits an estimation of the frequency response in the time domain using an oscilloscope.

The disadvantage is that the analysis is performed only on the frequencies that are present in the signal. As a result, any passband ripple might not be captured completely.

The **Multiburst Flag Ampl (Abs)** and **Multiburst Flag Ampl (Nom)** measurements capture the size of the reference pulse. This makes it possible to check whether the level of the test signal is correct. The amplitude of the multiburst flag is output as an absolute value in mV and in %, relative to the nominal value.

The **Multiburst 1 Ampl** through **Multiburst 6 Ampl** measurements describe the level deviations compared with the reference pulse at the frequency of packets 1 through 6. The deviation is defined linearly as a % and logarithmically in dB.

The **Multiburst 1 Frequ** through **Multiburst 6 Frequ** measurements capture the actual frequencies of the individual burst packets in MHz. The nominal value of the frequencies is dependent on the video format and the test signal (see Appendix A.3).

### 7.4.2.2 Test Locations

| Test locations | | |
|---|---|---|
| 1 | Flag High | Level of luminance flag high |
| 2 | Flag Low | Level of luminance flag low |
| 3 | Packet 1 | Location of the first frequency packet |
| 4 | Packet 2 | Location of the second frequency packet |
| 5 | Packet 3 | Location of the third frequency packet |
| 6 | Packet 4 | Location of the fourth frequency packet |
| 7 | Packet 5 | Location of the fifth frequency packet |
| 8 | Packet 6 | Location of the sixth frequency packet |

**Table 7-13: Test locations for the multiburst measurements.**

### 7.4.2.3 YPbPr Test Signal

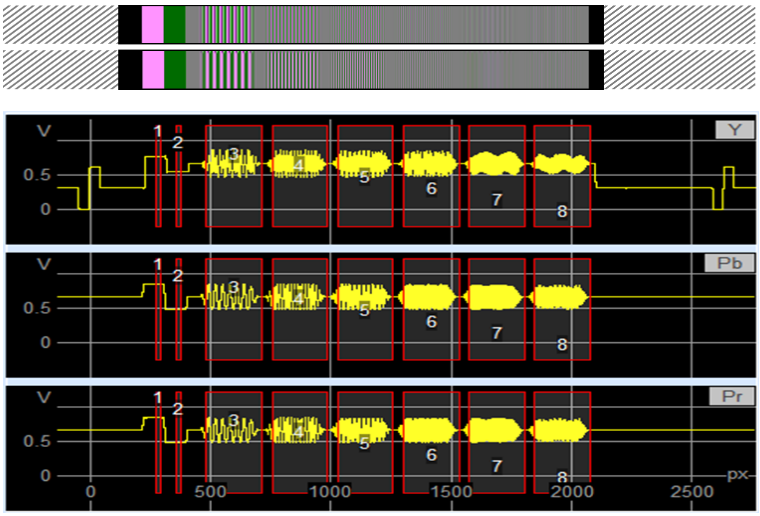


**Fig. 7-24: Measurement of the multiburst amplitude on the YPbPr "Multiburst" test signal. The top display of the multiburst reproduction on a screen shows the mixed multiburst, the bottom display shows the half multiburst.**

In the case of the YPbPr signal, the test locations in the Y channel can be set independently of the test locations in the PbPr video component signals. The test locations for the frequency packets are the same in all three components.

### 7.4.2.4 GBR Test Signal

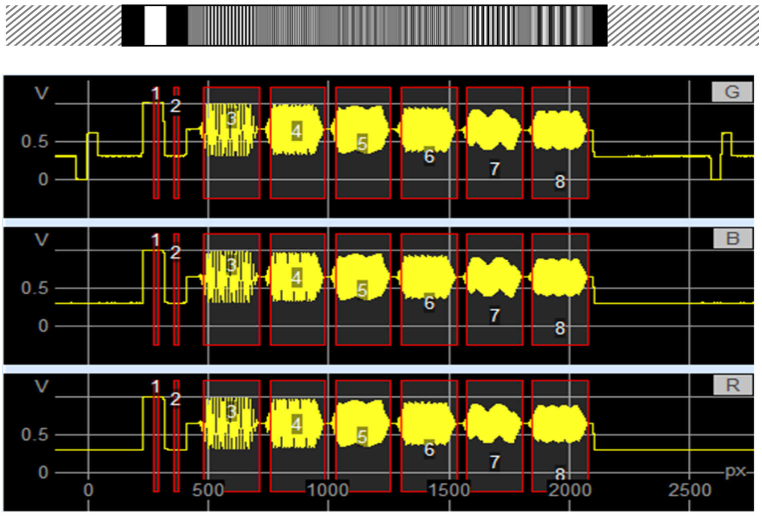


**Fig. 7-25: Measurement of the multiburst amplitude on the GBR "Multiburst" test signal.**

### 7.4.3 Sweep Amplitude

#### 7.4.3.1 Definition

Like the SIN X/X signal, the sweep signal covers the entire frequency range to the band limit. This means that a FFT can be used to automatically determine the frequency response. By using an oscilloscope, it is also possible to estimate the amplitude frequency response in the time domain.

The measured value **Sweep Amplitude** captures the amplitude frequency response of the signal.

The measured values are defined as the largest positive and the largest negative deviation in the frequency range as given in Table 7-11.

#### 7.4.3.2 Test Locations

| Test location | | |
|---|---|---|
| 1 | Sweep | Location and duration of the sweep signal |

**Fig. 7-26: Measurement of the multiburst amplitude on the GBR "Multiburst" test signal.**

#### 7.4.3.3 YPbPr Test Signal

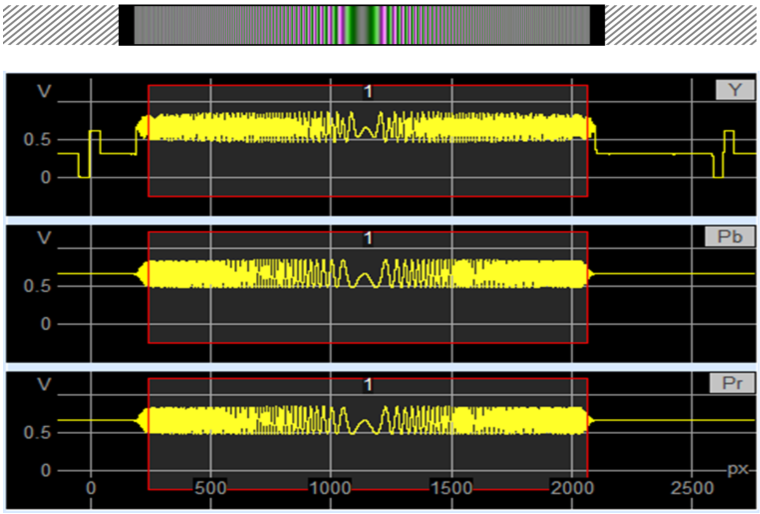


**Fig. 7-27: Measurement of the sweep amplitude on the YPbPr "Sweep" test signal.**

### 7.4.3.4 GBR Test Signal

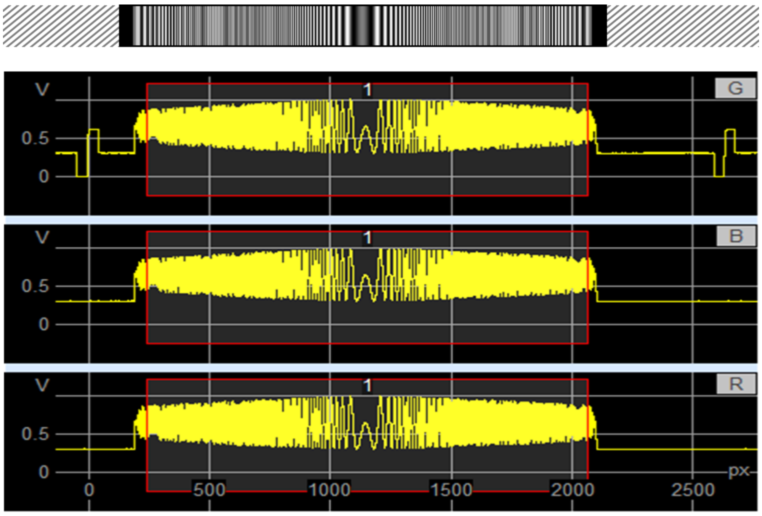


**Fig. 7-28: Measurement of the sweep amplitude on the GBR "Sweep" test signal.**

# 7.5 Noise Measurements

## 7.5.1 Signal to Noise Unweighted, Signal to Noise Luminance Weighted

### 7.5.1.1 Definition

The superposition of interference signals on the video signal can have different causes. Some examples are provided below:

- Wideband noise from signal amplifiers in the transmission chain
- Overtalk from other signals
- Interference in the power supply
- Quantization errors on A/D and D/A converters

Besides the size of the interference, its spectral distribution is decisive in determining whether the interference will be perceived visually. This is because the human eye is less sensitive to high-frequency interference. It is possible to compensate for this situation by using weighting filters. The transmission format of the weighting filter was originally defined for analog standard TV signals.

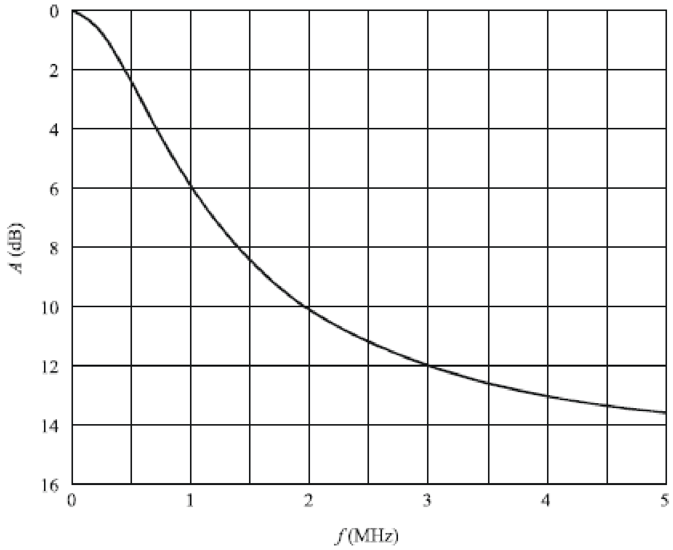


**Fig. 7-29: Frequency response of a weighting filter for analog video signals with a bandwidth of 5 MHz.**

There is no corresponding definition for HDTV signals. Therefore, the characteristic of the weighting filter shown above is calculated up to the bandwidth for the signal of interest.

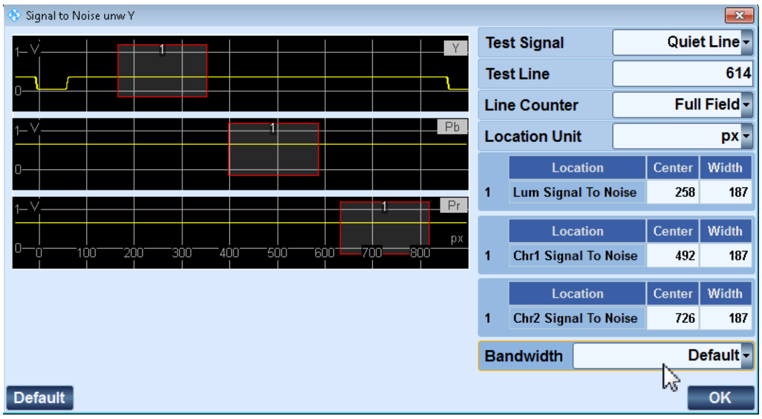
The **Signal to Noise Unw** measurement defines the ratio of unweighted noise voltage to the nominal signal level of 700 mV.

The **Signal to Noise Lumw** measurement defines the ratio of weighted noise voltage to the nominal signal level of 700 mV.

The spectral distribution of the noise voltage can be ascertained from the difference between the two measured values. If the noise signals are evenly distributed over the bandwidth (white noise), the signal-to-noise ratio of the unweighted measurement is 7.4 dB worse than the weighted measurement. If the difference is greater, then this interference has a larger component in the upper frequency domain. The same applies in reverse to smaller differences.

Otherwise, the noise voltage is captured up to the band limit of the signal. However, the analyzer includes filter settings for limiting the measurement bandwidth to 4.2 MHz, 5 MHz and 20 MHz. These filters serve only to ensure that the test instrument remains compatible with old T&M equipment, which often cannot cover the entire frequency bandwidth of a modern HDTV signal.

The bandwidth is selected via a menu in the "Signal to Noise" settings dialog box.



Test Signal: Quiet Line

Test Line: 614

Line Counter: Full Field

Location Unit: px

| | Location | Center | Width |
|---|---|---|---|
| 1 | Lum Signal To Noise | 258 | 187 |

| | Location | Center | Width |
|---|---|---|---|
| 1 | Chr1 Signal To Noise | 492 | 187 |

| | Location | Center | Width |
|---|---|---|---|
| 1 | Chr2 Signal To Noise | 726 | 187 |

Bandwidth: Default

**Fig. 7-30: Selecting the measurement bandwidth for the signal-to-noise measurement.**

The following settings are available:

- "Default" – measurement to the signal band limit
- "4.2 MHz (NTC7)" – band limit at 4.7 MHz in line with NTC 7
- "5 MHz (NTC7)" – band limit at 4.7 MHz in line with NTC 7
- "Unified 20 MHz" – band limit at 20 MHz

The noise voltage is measured in a video line without picture content (quiet line). This can be a black or a gray line. If quantization interference from A/D and D/A converters is also to be captured, the noise voltage must be measured on a ramp.

### 7.5.1.2 Test Locations

| Test location | | |
|---|---|---|
| 1 | Signal to Noise | Measurement window for noise measurements in GBR components |

**Table 7-14: Test location for the signal-to-noise measurement.**

### 7.5.1.3 YPbPr Test Signal

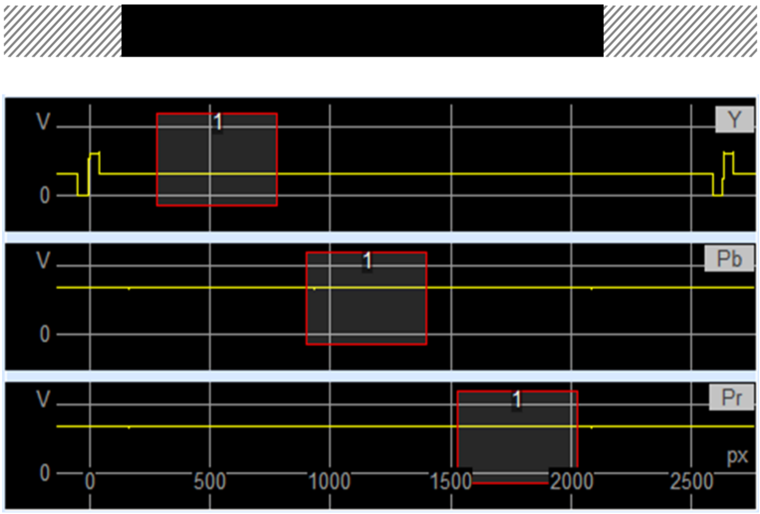


**Fig. 7-31: Signal-to-noise measurement on a YPbPr black line.**

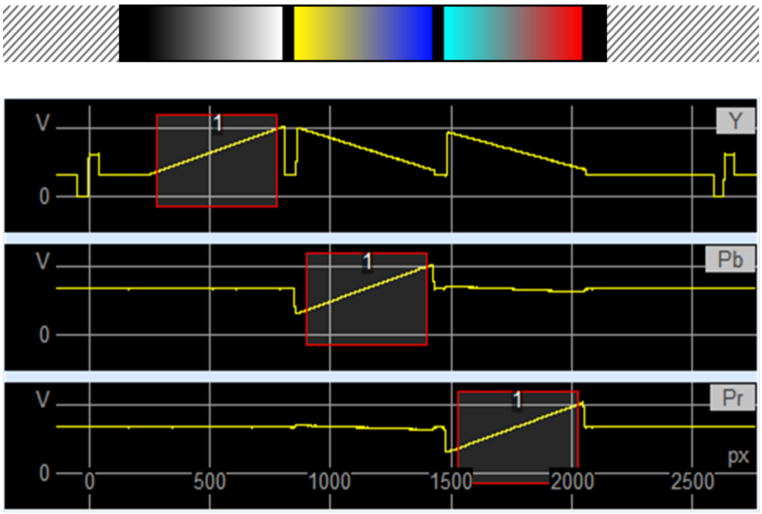


**Fig. 7-32: Signal-to-noise measurement on the YPbPr "Ramp" test signal.**

For the YPbPr signal, the test locations in the three video component signals can be set independently of one another.

### 7.5.1.4 GBR Test Signal

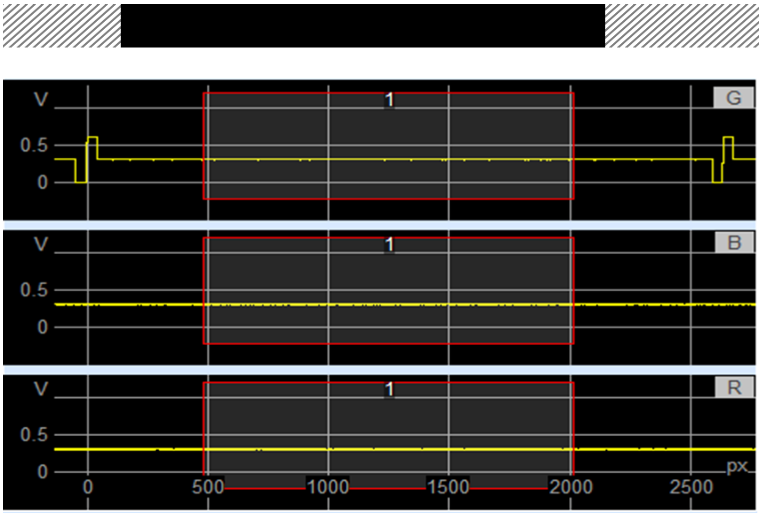


Fig. 7-33: Signal-to-noise measurement on a GBR black line.

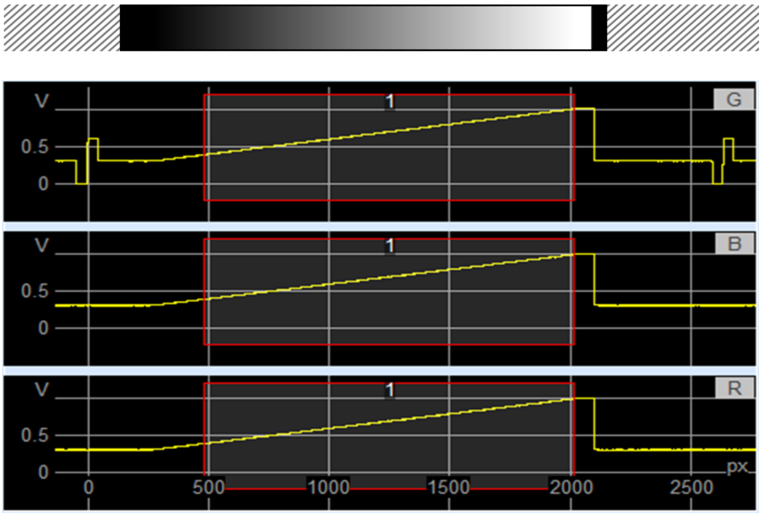


Fig. 7-34: Signal-to-noise measurement on the GBR "Ramp" test signal.

## 7.6 Timing

Time measurements check the temporal integrity of the video signal. This makes it possible to identify errors during the clock generation in the DUT.

## 7.6.1 Field Period

The **Field Period** measurement captures the period of the full field video. The measurement is taken on the sync pulses in the blanking intervals. It is therefore not necessary to make a specific test signal available for selection. The measured value is specified in µs.

## 7.6.2 Field Frequency

The **Field Frequency** measurement captures the repetition rate of the full field video. The measurement is taken on the sync pulses in the blanking interval. It is therefore not necessary to make a specific test signal available for selection. The measured value is specified in Hz.

## 7.6.3 Line Period

The **Line Period** measurement captures the duration of the video lines. The measurement is taken on the sync pulses in the blanking interval. It is therefore not necessary to make a specific test signal available for selection. The measured value is specified in µs.

## 7.6.4 Line Frequency

The **Line Frequency** measurement captures the repetition rate of the video lines. The measurement is taken on the sync pulses in the video content. It is therefore not necessary to make a specific test signal available for selection. The measured value is specified in Hz.

## 7.6.5 Lum Bar Duration

The **Lum Bar Duration** measurement captures the width of the white pulse and thus the timing in the active picture range. The test signal is a test line with a white pulse as contained in the "T2 Pulse & Bar" test line. The measured value is specified in µs.

### 7.6.5.1 Test Locations

| Test locations | | |
|---|---|---|
| 1 | Rising Slope | Position of the rising slope for the white pulse |
| 2 | Falling Slope | Position of the falling slope for the white pulse |

**Table 7-15: Test locations for the luminance bar duration measurement.**

The position of the rising slope of the luminance bar also serves as time reference point for all other measurements. This automatically compensates for any shifts of the picture content relative to the synchronous frame. If the luminance bar is not present, the nominal value is used as reference.

### 7.6.5.2 YPbPr Test Signal

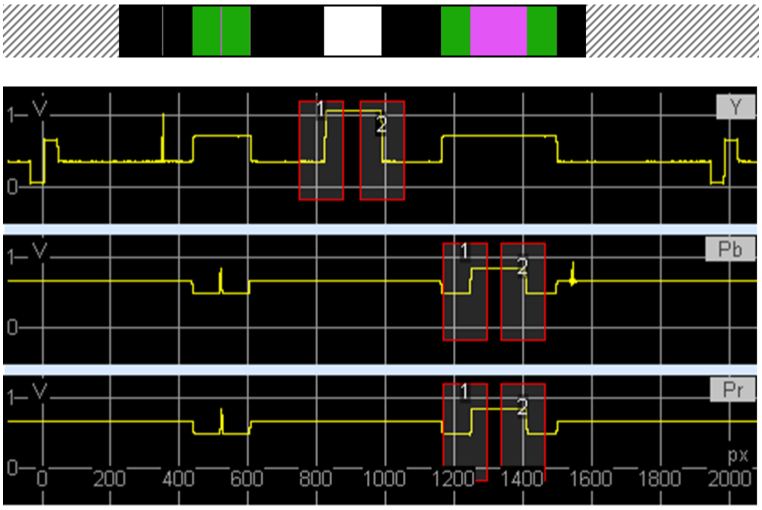


**Fig. 7-35: Measuring the luminance bar amplitude on YPbPr "2T Pulse & Bar" test signal.**

For the YPbPr signal, the test locations in the three video component signals can be set independently of one another.

### 7.6.5.3 GBR Test Signal

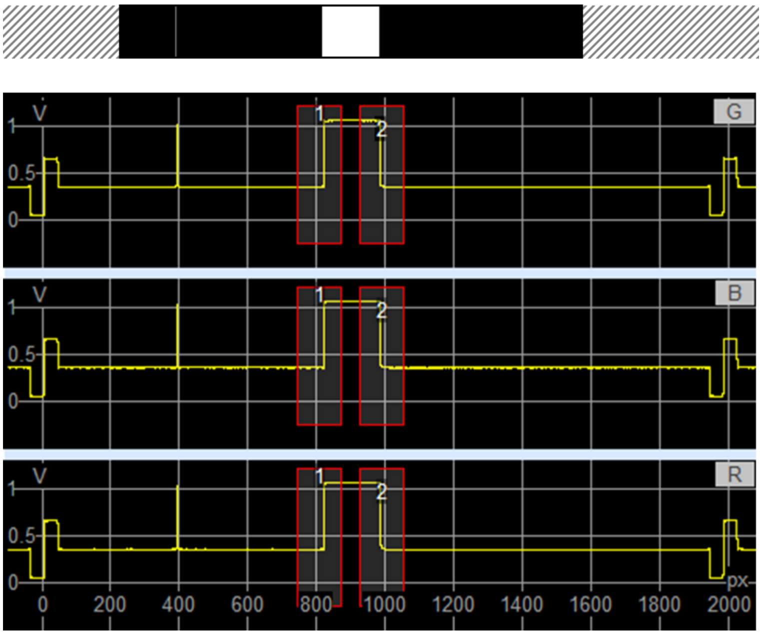


**Fig. 7-36: Measuring the luminance bar duration on GBR "2T Pulse & Bar" test signal.**

# 7.7 Jitter

Jitter measurements assess the temporal stability of the video signal. With digital processing of the video signal in UEs, signal jitter is typically no longer visible in the picture. However, the jitter measurement still makes sense because it can be used to identify problems during clock regeneration in the DUT.

The measurement is taken on the sync pulses in the active video content. It is therefore not necessary to make a specific test signal available for selection.

## 7.7.1 Line Jitter Pos Peak, Line Jitter Neg Peak, Line Jitter pp

The **Line Jitter Pos Peak** and **Line Jitter Neg Peak** measurements capture the longest or the shortest video line in full field. The difference to the average length of all video lines in full field is output. The **Line Jitter pp** measurement specifies the sum of the **Line Jitter Pos Peak** and **Line Jitter Neg Peak** measurements. The measured value is specified in ns.

## 7.7.2 Line Jitter Std. Deviation

**Line Jitter Std. Dev** specifies the standard deviation of the line duration of all lines of a full field. No unit is assigned to the measured value.

# 8 Ordering Information

| **Designation** | **Type** | **Order No.** |
|---|---|---|
| Video Test Center (base unit, 4 HU) | R&S®VTC | 2115.7400.02 |
| Video Tester (base unit, 3 HU) | R&S®VTE | 2115.7300.02 |
| Compact Video Tester (base unit, 1 HU) | R&S®VTS | 2115.7100.02 |
| Broadcast Test Center (base unit, 4 HU) | R&S®BTC | 2114.3000.02 |
| | | |
| Analog A/V RX (input module) | R&S®VT-B2370 | 2115.7600.06 |
| Broadcast TX Modulator<br>(+ coder options, not for R&S®BTC) | R&S®VT-B600 | 2115.7522.06 |
| | | |
| Video Analysis (software) | R&S®VT-K2100 | 2115.8029.02 |
| Video Measurements (software) | R&S®VT-K2101 | 2115.8264.02 |
| Component Support (software) | R&S®VT-K2371 | 2115.8258.02 |

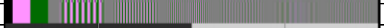
# Appendix

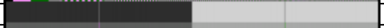
# A Rohde & Schwarz Combined Test Pattern

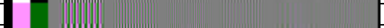
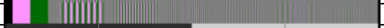
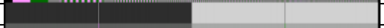
## A.1 Test Signal Mapping of Interlaced Formats

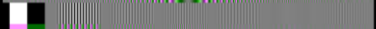
| Signal | 720 x 480i - Field 1 | Active Field Line | | | Full Flield Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 1 | 15 | 29 | 22 | 29 | 36 |
| Color Bars Y,Cb,Cr | | 32 | 46 | 59 | 37 | 44 | 51 |
| Horizontal Sweep GBR | | 63 | 76 | 89 | 52 | 59 | 66 |
| Horizontal Sweep Y.Cb,Cr | | 94 | 107 | 119 | 67 | 74 | 81 |
| Multiburst RGB | | 125 | 137 | 149 | 82 | 89 | 96 |
| Multiburst Y.Cb,Cr mixed | | 156 | 168 | 179 | 97 | 104 | 111 |
| Multiburst Y.Cb,Cr half | | 187 | 198 | 209 | 112 | 119 | 126 |
| Sin(x)/x RGB | | 218 | 229 | 239 | 127 | 134 | 141 |
| Sin(x)/x Y,Cb,Cr | | 249 | 259 | 269 | 142 | 149 | 156 |
| 2T Pulse and Bar GBR | | 280 | 290 | 299 | 157 | 164 | 171 |
| 2T Pulse and Bar Y,Cb,Cr | | 311 | 320 | 329 | 172 | 179 | 186 |
| Ramp RGB | | 342 | 351 | 359 | 187 | 194 | 201 |
| Valid Ramp Y,Cb,Cr(GBR) | | 373 | 381 | 389 | 202 | 209 | 216 |
| Stairs RGB | | 404 | 412 | 419 | 217 | 224 | 231 |
| Valid Stairs Y,Cb,Cr(GBR) | | 435 | 442 | 449 | 232 | 239 | 246 |
| Quiet Line | | 466 | 473 | 479 | 247 | 254 | 261 |

| Signal | 720 x 480i - Field 2 | Active Field Line | | | Full Flield Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 2 | 16 | 30 | 285 | 292 | 299 |
| Color Bars Y,Cb,Cr | | 33 | 47 | 60 | 300 | 307 | 314 |
| Horizontal Sweep GBR | | 64 | 77 | 90 | 315 | 322 | 329 |
| Horizontal Sweep Y.Cb,Cr | | 95 | 108 | 120 | 330 | 337 | 344 |
| Multiburst RGB | | 126 | 138 | 150 | 345 | 352 | 359 |
| Multiburst Y.Cb,Cr mixed | | 157 | 169 | 180 | 360 | 367 | 374 |
| Multiburst Y.Cb,Cr half | | 188 | 199 | 210 | 375 | 382 | 389 |
| Sin(x)/x RGB | | 219 | 230 | 240 | 390 | 397 | 404 |
| Sin(x)/x Y,Cb,Cr | | 250 | 260 | 270 | 405 | 412 | 419 |
| 2T Pulse and Bar GBR | | 281 | 291 | 300 | 420 | 427 | 434 |
| 2T Pulse and Bar Y,Cb,Cr | | 312 | 321 | 330 | 435 | 442 | 449 |
| Ramp RGB | | 343 | 352 | 360 | 450 | 457 | 464 |
| Valid Ramp Y,Cb,Cr(GBR) | | 374 | 382 | 390 | 465 | 472 | 479 |
| Stairs RGB | | 405 | 413 | 420 | 480 | 487 | 494 |
| Valid Stairs Y,Cb,Cr(GBR) | | 436 | 443 | 450 | 495 | 502 | 509 |
| Quiet Line | | 467 | 474 | 480 | 510 | 517 | 524 |

| Signal | 720 x 576i - Field 1 | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 1 | 18 | 35 | 23 | 32 | 40 |
| Color Bars Y,Cb,Cr |  | 32 | 52 | 71 | 41 | 50 | 58 |
| Horizontal Sweep GBR |  | 63 | 85 | 107 | 59 | 68 | 76 |
| Horizontal Sweep Y.Cb,Cr |  | 94 | 119 | 143 | 77 | 86 | 94 |
| Multiburst RGB |  | 125 | 152 | 179 | 95 | 104 | 112 |
| Multiburst Y.Cb,Cr mixed |  | 156 | 186 | 215 | 113 | 122 | 130 |
| Multiburst Y.Cb,Cr half |  | 187 | 219 | 251 | 131 | 140 | 148 |
| Sin(x)/x RGB |  | 218 | 253 | 287 | 149 | 158 | 166 |
| Sin(x)/x Y,Cb,Cr |  | 249 | 286 | 323 | 167 | 176 | 184 |
| 2T Pulse and Bar GBR |  | 280 | 320 | 359 | 185 | 194 | 202 |
| 2T Pulse and Bar Y,Cb,Cr |  | 311 | 353 | 395 | 203 | 212 | 220 |
| Ramp RGB |  | 342 | 387 | 431 | 221 | 230 | 238 |
| Valid Ramp Y,Cb,Cr(GBR) |  | 373 | 420 | 467 | 239 | 248 | 256 |
| Stairs RGB |  | 404 | 454 | 503 | 257 | 266 | 274 |
| Valid Stairs Y,Cb,Cr(GBR) |  | 435 | 487 | 539 | 275 | 284 | 292 |
| Quiet Line | | 466 | 521 | 575 | 293 | 302 | 310 |

| Signal | 720 x 576i - Field 2 | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 2 | 19 | 36 | 336 | 345 | 353 |
| Color Bars Y,Cb,Cr |  | 33 | 53 | 72 | 354 | 363 | 371 |
| Horizontal Sweep GBR |  | 64 | 86 | 108 | 372 | 381 | 389 |
| Horizontal Sweep Y.Cb,Cr |  | 95 | 120 | 144 | 390 | 399 | 407 |
| Multiburst RGB |  | 126 | 153 | 180 | 408 | 417 | 425 |
| Multiburst Y.Cb,Cr mixed |  | 157 | 187 | 216 | 426 | 435 | 443 |
| Multiburst Y.Cb,Cr half |  | 188 | 220 | 252 | 444 | 453 | 461 |
| Sin(x)/x RGB |  | 219 | 254 | 288 | 462 | 471 | 479 |
| Sin(x)/x Y,Cb,Cr |  | 250 | 287 | 324 | 480 | 489 | 497 |
| 2T Pulse and Bar GBR |  | 281 | 321 | 360 | 498 | 507 | 515 |
| 2T Pulse and Bar Y,Cb,Cr |  | 312 | 354 | 396 | 516 | 525 | 533 |
| Ramp RGB |  | 343 | 388 | 432 | 534 | 543 | 551 |
| Valid Ramp Y,Cb,Cr(GBR) |  | 374 | 421 | 468 | 552 | 561 | 569 |
| Stairs RGB |  | 405 | 455 | 504 | 570 | 579 | 587 |
| Valid Stairs Y,Cb,Cr(GBR) |  | 436 | 488 | 540 | 588 | 597 | 605 |
| Quiet Line | | 467 | 522 | 576 | 606 | 615 | 623 |

| Signal | 1920 x 1080i - Field 1 | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 1 | 34 | 66 | 21 | 38 | 54 |
| Color Bars Y,Cb,Cr |  | 32 | 67 | 102 | 55 | 71 | 87 |
| Horizontal Sweep GBR |  | 63 | 101 | 138 | 88 | 105 | 121 |
| Horizontal Sweep Y.Cb,Cr |  | 94 | 134 | 174 | 122 | 138 | 154 |
| Multiburst RGB |  | 125 | 168 | 210 | 155 | 172 | 188 |
| Multiburst Y.Cb,Cr mixed |  | 156 | 201 | 246 | 189 | 205 | 221 |
| Multiburst Y.Cb,Cr half |  | 187 | 235 | 282 | 222 | 239 | 255 |
| Sin(x)/x RGB |  | 218 | 268 | 318 | 256 | 272 | 288 |
| Sin(x)/x Y,Cb,Cr |  | 249 | 302 | 354 | 289 | 306 | 322 |
| 2T Pulse and Bar GBR |  | 280 | 335 | 390 | 323 | 339 | 355 |
| 2T Pulse and Bar Y,Cb,Cr |  | 311 | 369 | 426 | 356 | 373 | 389 |
| Ramp RGB |  | 342 | 402 | 462 | 390 | 406 | 422 |
| Valid Ramp Y,Cb,Cr(GBR) |  | 373 | 436 | 498 | 423 | 440 | 456 |
| Stairs RGB |  | 404 | 469 | 534 | 457 | 473 | 489 |
| Valid Stairs Y,Cb,Cr(GBR) |  | 435 | 503 | 570 | 490 | 507 | 523 |
| Quiet Line | | 466 | 536 | 606 | 524 | 540 | 556 |

| Signal | 1920 x 1080i - Field 2 | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 2 | 35 | 67 | 584 | 601 | 617 |
| Color Bars Y,Cb,Cr |  | 33 | 68 | 103 | 618 | 634 | 650 |
| Horizontal Sweep GBR |  | 64 | 102 | 139 | 651 | 668 | 684 |
| Horizontal Sweep Y.Cb,Cr |  | 95 | 135 | 175 | 685 | 701 | 717 |
| Multiburst RGB |  | 126 | 169 | 211 | 718 | 735 | 751 |
| Multiburst Y.Cb,Cr mixed |  | 157 | 202 | 247 | 752 | 768 | 784 |
| Multiburst Y.Cb,Cr half |  | 188 | 236 | 283 | 785 | 802 | 818 |
| Sin(x)/x RGB |  | 219 | 269 | 319 | 819 | 835 | 851 |
| Sin(x)/x Y,Cb,Cr |  | 250 | 303 | 355 | 852 | 869 | 885 |
| 2T Pulse and Bar GBR |  | 281 | 336 | 391 | 886 | 902 | 918 |
| 2T Pulse and Bar Y,Cb,Cr |  | 312 | 370 | 427 | 919 | 936 | 952 |
| Ramp RGB |  | 343 | 403 | 463 | 953 | 969 | 985 |
| Valid Ramp Y,Cb,Cr(GBR) |  | 374 | 437 | 499 | 986 | 1003 | 1019 |
| Stairs RGB |  | 405 | 470 | 535 | 1020 | 1036 | 1052 |
| Valid Stairs Y,Cb,Cr(GBR) |  | 436 | 504 | 571 | 1053 | 1070 | 1086 |
| Quiet Line | | 467 | 537 | 607 | 1087 | 1103 | 1119 |

## A.2 Test Signal Mapping of Progressive Formats

| Signal | 720 x 480p | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 1 | 16 | 30 | 43 | 58 | 72 |
| Color Bars Y,Cb,Cr | | 31 | 46 | 60 | 73 | 88 | 102 |
| Horizontal Sweep GBR | | 61 | 76 | 90 | 103 | 118 | 132 |
| Horizontal Sweep Y.Cb,Cr | | 91 | 106 | 120 | 133 | 148 | 162 |
| Multiburst RGB | | 121 | 136 | 150 | 163 | 178 | 192 |
| Multiburst Y.Cb,Cr mixed | | 151 | 166 | 180 | 193 | 208 | 222 |
| Multiburst Y.Cb,Cr half | | 181 | 196 | 210 | 223 | 238 | 252 |
| Sin(x)/x RGB | | 211 | 226 | 240 | 253 | 268 | 282 |
| Sin(x)/x Y,Cb,Cr | | 241 | 256 | 270 | 283 | 298 | 312 |
| 2T Pulse and Bar GBR | | 271 | 286 | 300 | 313 | 328 | 342 |
| 2T Pulse and Bar Y,Cb,Cr | | 301 | 316 | 330 | 343 | 358 | 372 |
| Ramp RGB | | 331 | 346 | 360 | 373 | 388 | 402 |
| Valid Ramp Y,Cb,Cr(GBR) | | 361 | 376 | 390 | 403 | 418 | 432 |
| Stairs RGB | | 391 | 406 | 420 | 433 | 448 | 462 |
| Valid Stairs Y,Cb,Cr(GBR) | | 421 | 436 | 450 | 463 | 478 | 492 |
| Quiet Line | | 451 | 466 | 480 | 493 | 508 | 522 |

| Signal | 720 x 576p | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 1 | 19 | 36 | 45 | 63 | 80 |
| Color Bars Y,Cb,Cr | | 37 | 55 | 72 | 81 | 99 | 116 |
| Horizontal Sweep GBR | | 73 | 91 | 108 | 117 | 135 | 152 |
| Horizontal Sweep Y.Cb,Cr | | 109 | 127 | 144 | 153 | 171 | 188 |
| Multiburst RGB | | 145 | 163 | 180 | 189 | 207 | 224 |
| Multiburst Y.Cb,Cr mixed | | 181 | 199 | 216 | 225 | 243 | 260 |
| Multiburst Y.Cb,Cr half | | 217 | 235 | 252 | 261 | 279 | 296 |
| Sin(x)/x RGB | | 253 | 271 | 288 | 297 | 315 | 332 |
| Sin(x)/x Y,Cb,Cr | | 289 | 307 | 324 | 333 | 351 | 368 |
| 2T Pulse and Bar GBR | | 325 | 343 | 360 | 369 | 387 | 404 |
| 2T Pulse and Bar Y,Cb,Cr | | 361 | 379 | 396 | 405 | 423 | 440 |
| Ramp RGB | | 397 | 415 | 432 | 441 | 459 | 476 |
| Valid Ramp Y,Cb,Cr(GBR) | | 433 | 451 | 468 | 477 | 495 | 512 |
| Stairs RGB | | 469 | 487 | 504 | 513 | 531 | 548 |
| Valid Stairs Y,Cb,Cr(GBR) | | 505 | 523 | 540 | 549 | 567 | 584 |
| Quiet Line | | 541 | 559 | 576 | 585 | 603 | 620 |

| Signal | 1280 x 720p | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 1 | 23 | 45 | 26 | 48 | 70 |
| Color Bars Y,Cb,Cr | | 46 | 68 | 90 | 71 | 93 | 115 |
| Horizontal Sweep GBR | | 91 | 113 | 135 | 116 | 138 | 160 |
| Horizontal Sweep Y.Cb,Cr | | 136 | 158 | 180 | 161 | 183 | 205 |
| Multiburst RGB | | 181 | 203 | 225 | 206 | 228 | 250 |
| Multiburst Y.Cb,Cr mixed | | 226 | 248 | 270 | 251 | 273 | 295 |
| Multiburst Y.Cb,Cr half | | 271 | 293 | 315 | 296 | 318 | 340 |
| Sin(x)/x RGB | | 316 | 338 | 360 | 341 | 363 | 385 |
| Sin(x)/x Y,Cb,Cr | | 361 | 383 | 405 | 386 | 408 | 430 |
| 2T Pulse and Bar GBR | | 406 | 428 | 450 | 431 | 453 | 475 |
| 2T Pulse and Bar Y,Cb,Cr | | 451 | 473 | 495 | 476 | 498 | 520 |
| Ramp RGB | | 496 | 518 | 540 | 521 | 543 | 565 |
| Valid Ramp Y,Cb,Cr(GBR) | | 541 | 563 | 585 | 566 | 588 | 610 |
| Stairs RGB | | 586 | 608 | 630 | 611 | 633 | 655 |
| Valid Stairs Y,Cb,Cr(GBR) | | 631 | 653 | 675 | 656 | 678 | 700 |
| Quiet Line | | 676 | 698 | 720 | 701 | 723 | 745 |

| Signal | 1920 x 1080p | Active Field Line | | | Full Field Line | | |
|---|---|---|---|---|---|---|---|
| | | First | Middle | Last | First | Middle | Last |
| Color Bars GBR |  | 1 | 34 | 67 | 42 | 75 | 108 |
| Color Bars Y,Cb,Cr | | 68 | 101 | 134 | 109 | 142 | 175 |
| Horizontal Sweep GBR | | 135 | 168 | 201 | 176 | 209 | 242 |
| Horizontal Sweep Y.Cb,Cr | | 202 | 235 | 268 | 243 | 276 | 309 |
| Multiburst RGB | | 269 | 302 | 335 | 310 | 343 | 376 |
| Multiburst Y.Cb,Cr mixed | | 336 | 369 | 402 | 377 | 410 | 443 |
| Multiburst Y.Cb,Cr half | | 403 | 436 | 469 | 444 | 477 | 510 |
| Sin(x)/x RGB | | 470 | 503 | 536 | 511 | 544 | 577 |
| Sin(x)/x Y,Cb,Cr | | 537 | 570 | 603 | 578 | 611 | 644 |
| 2T Pulse and Bar GBR | | 604 | 637 | 670 | 645 | 678 | 711 |
| 2T Pulse and Bar Y,Cb,Cr | | 671 | 704 | 737 | 712 | 745 | 778 |
| Ramp RGB | | 738 | 771 | 804 | 779 | 812 | 845 |
| Valid Ramp Y,Cb,Cr(GBR) | | 805 | 838 | 871 | 846 | 879 | 912 |
| Stairs RGB | | 872 | 905 | 938 | 913 | 946 | 979 |
| Valid Stairs Y,Cb,Cr(GBR) | | 939 | 972 | 1005 | 980 | 1013 | 1046 |
| Quiet Line | | 1006 | 1043 | 1080 | 1047 | 1084 | 1121 |

## A.3 Timing and Frequencies

| Parameter | Unit | 720x480i | 720x576i | 1920x1080i | 720x480p | 720x576p | 1280x720p | 1920x1080p |
|---|---|---|---|---|---|---|---|---|
| Number of total lines | | 525 | 625 | 1125 | 525 | 625 | 750 | 1125 |
| Frame rate | Hz | 29.97/30 | 25 | 50/59.94/60 | 59.94/60 | 50 | 50/59.94/60 | 50/59.94/60 |
| Sync pulse | | Bi-Level | Bi-Level | Tri-Level | Bi-Level | Bi-Level | Tri-Level | Tri-Level |
| Pixel frequency | MHz | 13.5 | 13.5 | 74.25 | 27 | 27 | 74.250 | 148.5 |
| Bandwidth Y/G/B/R | MHz | 4 | 5 | 30 | 12 | 12 | 30 | 60 |
| Bandwidth Pb/Pr | MHz | 2 | 2.5 | 15 | 6 | 6 | 15 | 30 |
| 2T Half amplitude duration Y/G/B/R | ns | 250 | 200 | 33 | 83 | 83 | 33 | 17 |
| 2T Half amplitude duration PbPr | ns | 500 | 400 | 67 | 167 | 167 | 67 | 33 |
| 10 to 90 % rise and fall time Y/G/B/R | ns | 148 | 118 | 19.677 | 49 | 49 | 20 | 10 |
| 10 to 90 % rise and fall time PbPr | ns | 295 | 236 | 39 | 98 | 98 | 39 | 20 |
| Multiburst frequency Y/G/B/R packed 1 | MHz | 1.00 | 1.00 | 5.00 | 2.00 | 2.00 | 5.00 | 10.00 |
| Multiburst frequency Y/G/B/R packed 2 | MHz | 2.00 | 2.00 | 10.00 | 4.00 | 4.00 | 10.00 | 20.00 |
| Multiburst frequency Y/G/B/R packed 3 | MHz | 3.00 | 3.00 | 15.00 | 6.00 | 6.00 | 15.00 | 30.00 |
| Multiburst frequency Y/G/B/R packed 4 | MHz | 4.00 | 4.00 | 20.00 | 8.00 | 8.00 | 20.00 | 40.00 |
| Multiburst frequency Y/G/B/R packed 5 | MHz | 5.00 | 5.00 | 25.00 | 10.00 | 10.00 | 25.00 | 50.00 |
| Multiburst frequency Y/G/B/R packed 6 | MHz | 6.00 | 6.00 | 30.00 | 12.00 | 12.00 | 30.00 | 60.00 |
| Multiburst frequency Pb/Pr packed 1 | MHz | 0.50 | 0.50 | 2.50 | 1.00 | 1.00 | 2.50 | 5.00 |
| Multiburst frequency Pb/Pr packed 2 | MHz | 1.00 | 1.00 | 5.00 | 2.00 | 2.00 | 5.00 | 10.00 |
| Multiburst frequency Pb/Pr packed 3 | MHz | 1.50 | 1.50 | 7.50 | 3.00 | 3.00 | 7.50 | 15.00 |
| Multiburst frequency Pb/Pr packed 4 | MHz | 2.00 | 2.00 | 10.00 | 4.00 | 4.00 | 10.00 | 20.00 |
| Multiburst frequency Pb/Pr packed 5 | MHz | 2.50 | 2.50 | 12.50 | 5.00 | 5.00 | 12.50 | 25.00 |
| Multiburst frequency Pb/Pr packed 6 | MHz | 3.00 | 3.00 | 15.00 | 6.00 | 6.00 | 15.00 | 30.00 |

## A.4 Color Bars Signal Level

| 100% SDTV Color Bars | R mV | G mV | B mV | Y mV | Pb mV | Pr mV | Chr. level mV | Chr. Phase deg |
|---|---|---|---|---|---|---|---|---|
| White | 700 | 700 | 700 | 700.0 | 0.0 | 0.0 | 0.0 | n.a. |
| Yellow | 700 | 700 | 0 | 620.2 | -350.0 | 56.7 | 354.6 | 170.8 |
| Cyan | 0 | 700 | 700 | 490.7 | 118.3 | -350.0 | 369.5 | 288.7 |
| Green | 0 | 700 | 0 | 410.9 | -231.7 | -293.3 | 373.8 | 231.7 |
| Magenta | 700 | 0 | 700 | 289.1 | 231.7 | 293.3 | 373.8 | 51.7 |
| Red | 700 | 0 | 0 | 209.3 | -118.3 | 350.0 | 369.5 | 108.7 |
| Blue | 0 | 0 | 700 | 79.8 | 350.0 | -56.7 | 354.6 | 350.8 |
| Black | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | n.a. |

**Levels of 100 % color bars for SDTV.**

| 100% HDTV Color Bars | R mV | G mV | B mV | Y mV | Pb mV | Pr mV | Chr. Level mV | Chr. Phase deg |
|---|---|---|---|---|---|---|---|---|
| White | 700 | 700 | 700 | 700 | 0 | 0 | 0.0 | n.a. |
| Yellow | 700 | 700 | 0 | 650 | -350 | 32 | 351.5 | 180.0 |
| Cyan | 0 | 700 | 700 | 551 | 81 | -350 | 359.1 | 360.0 |
| Green | 0 | 700 | 0 | 501 | -270 | -318 | 416.7 | 180.0 |
| Magenta | 700 | 0 | 700 | 200 | 270 | 318 | 416.7 | 0.0 |
| Red | 700 | 0 | 0 | 149 | -81 | 350 | 359.1 | 180.0 |
| Blue | 0 | 0 | 700 | 50 | 350 | -32 | 351.5 | 360.0 |
| Black | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | n.a. |

**Levels of 100 % color bars for HDTV.**

# B Mapping of Measurements and Test Signals

| Measurement | Test signal(s) |
|---|---|
| **Amplitude and delay** | |
| Luminance Bar Amplitude | 2T Pulse & Bar |
| Sync Amplitude | 2T Pulse & Bar, Color Bars, SIN X/X, Sweep, Multiburst, Quiet Line, Ramp |
| Color Bar Amplitude | Color Bars |
| Inter Channel Delay and Amplitude | Color Bars |
| **Linear distortions** | |
| 2T Pulse Amplitude, k-Factor and HAD | 2T Pulse & Bar |
| ST Distortion Rise/Fall Time, Preshoot and Overshoot | 2T Pulse & Bar |
| **Nonlinear distortions** | |
| Nonlinearity, Nonlinearity Step 1 to Step 5 | 2T Pulse & Bar |
| **Frequency response** | |
| SIN X/X Amplitude and Delay | SIN X/X |
| Sweep Amplitude | Sweep |
| Multiburst Flag Amplitude<br>Multiburst 1 to 6 Amplitude<br>Multiburst 1 to 6 Frequency | Multiburst |
| **Noise measurements** | |
| Signal to Noise Unweighted and Weighted | Quiet Line, Ramp |
| **Timing** | |
| Field Period and Frequency | Full Field |
| Line Period and Frequency | Full Field |
| Luminance Bar Duration | 2T Pulse & Bar |
| **Jitter** | |
| Line Jitter | Full Field |

**Mapping of measurements to test signals.**

# C Sample Measurement Log

| Measurement | Value | Lower Limit | Upper Limit | Unit | Status | Test Signal |
|---|---|---|---|---|---|---|
| Lum Bar Amplitude Y (nom) | 0,400535 | -5 | 5 | % | | 2T Pulse & Bar [498 FF] |
| Lum Bar Amplitude Pb (nom) | 0,808137 | -5 | 5 | % | | 2T Pulse & Bar [498 FF] |
| Lum Bar Amplitude Pr (nom) | 1,067076 | -5 | 5 | % | | 2T Pulse & Bar [498 FF] |
| Sync Amplitude Y (nom) | 0,109275 | -10 | 10 | % | | Sync Line [93 FF] |
| Inter Channel Delay (Y - Pb) | 12,774762 | -100 | 100 | ns | | Color Bars [93 FF] |
| Inter Channel Delay (Y - Pr) | -15,114892 | -100 | 100 | ns | | Color Bars [93 FF] |
| Inter Channel Delay (Pb - Pr) | -27,889654 | -100 | 100 | ns | | Color Bars [93 FF] |
| Inter Channel Ampl. (Y - Pb) | -0,525367 | -5 | 5 | % | | Color Bars [93 FF] |
| Inter Channel Ampl. (Y - Pr) | -0,618638 | -5 | 5 | % | | Color Bars [93 FF] |
| Inter Channel Ampl. (Pb - Pr) | -0,093764 | -5 | 5 | % | | Color Bars [93 FF] |
| 2T Pulse Amplitude Y | -0,964321 | -10 | 10 | % | | 2T Pulse & Bar [498 FF] |
| 2T Pulse Amplitude Pb | 0,796354 | -10 | 10 | % | | 2T Pulse & Bar [498 FF] |
| 2T Pulse Amplitude Pr | 0,294725 | -10 | 10 | % | | 2T Pulse & Bar [498 FF] |
| 2T Pulse k-Factor Y | 0,457808 | -0,1 | 4 | % | | 2T Pulse & Bar [498 FF] |
| 2T Pulse k-Factor Pb | 0,42727 | -0,1 | 4 | % | | 2T Pulse & Bar [498 FF] |
| 2T Pulse k-Factor Pr | 0,459688 | -0,1 | 4 | % | | 2T Pulse & Bar [498 FF] |
| ST Dist Rise Time Y | 21,767288 | 0 | 1000 | ns | | 2T Pulse & Bar [498 FF] |
| ST Dist Rise Time Pb | 42,554386 | 0 | 1000 | ns | | 2T Pulse & Bar [498 FF] |
| ST Dist Rise Time Pr | 42,986511 | 0 | 1000 | ns | | 2T Pulse & Bar [498 FF] |
| ST Dist Fall Time Y | 21,516178 | 0 | 1000 | ns | | 2T Pulse & Bar [498 FF] |
| ST Dist Fall Time Pb | 42,247524 | 0 | 1000 | ns | | 2T Pulse & Bar [498 FF] |
| ST Dist Fall Time Pr | 42,455929 | 0 | 1000 | ns | | 2T Pulse & Bar [498 FF] |
| Multiburst 1 Ampl. Y (dB) | -0,087994 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 1 Ampl. Pb (dB) | 0,062524 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 1 Ampl. Pr (dB) | 0,044235 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 2 Ampl. Y (dB) | -0,173898 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 2 Ampl. Pb (dB) | -0,072491 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 2 Ampl. Pr (dB) | -0,126012 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 3 Ampl. Y (dB) | -0,430626 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 3 Ampl. Pb (dB) | 0,029908 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 3 Ampl. Pr (dB) | -0,12146 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 4 Ampl. Y (dB) | -0,432895 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 4 Ampl. Pb (dB) | -0,109002 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 4 Ampl. Pr (dB) | -0,282501 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 5 Ampl. Y (dB) | -0,646353 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 5 Ampl. Pb (dB) | -0,270875 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 5 Ampl. Pr (dB) | -0,479595 | -1 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 6 Ampl. Y (dB) | -1,94915 | -6 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 6 Ampl. Pb (dB) | -3,328525 | -6 | 1 | dB | | Multiburst [273 FF] |
| Multiburst 6 Ampl. Pr (dB) | -3,402147 | -6 | 1 | dB | | Multiburst [273 FF] |
| Signal to Noise unw Y | 64,986 | 70 | 1000 | dB | LL | Quiet Line [723 FF] |
| Signal to Noise unw Pb | 69,47361 | 40 | 1000 | dB | | Quiet Line [723 FF] |
| Signal to Noise unw Pr | 68,658592 | 40 | 1000 | dB | | Quiet Line [723 FF] |
| Nonlinearity Y | 0,841979 | -0,1 | 10 | % | | Staircase [674 FF] |
| Nonlinearity Pb | 0,992864 | -0,1 | 10 | % | | Staircase [674 FF] |
| Nonlinearity Pr | 1,161308 | -0,1 | 10 | % | | Staircase [674 FF] |
| Field Period | 20000 | 1000 | 99999 | us | | Full Field |
| Line Period | 26,666666 | 5 | 1000 | us | | Full Field |
| Line Jitter pp | 1,014134 | -1000 | 1000 | ns | | Full Field |

**Log output for selected measurements on a YPbPr video signal.**

## Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, radiomonitoring and radiolocation. Founded more than 80 years ago, this independent company has an extensive sales and service network and is present in more than 70 countries.

The electronics group is among the world market leaders in its established business fields. The company is headquartered in Munich, Germany. It also has regional headquarters in Singapore and Columbia, Maryland, USA, to manage its operations in these regions.

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## Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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