ROHDE&SCHWARZ

BROADCASTING DIVISION

Application Note

Bandwidth of video signals from generators with purely digital signal generation

Products:

CCVS+COMPONENT GENERATOR	***SAF***
CCVS GENERATOR	***SFF***
TV GENERATORS	***SG.F***

7BM21_0E

Bandwidth of video signals from generators with purely digital signal generation

CCIR REC. 624 specifies a signal bandwidth of 5 MHz for standard B,G/PAL. Within this bandwidth, signal rise times or half-amplitude durations of $\sin^2$ pulses of up to 200 ns can be displayed almost undistorted with one restriction, however, namely these signals comprise spectral components outside the 5-MHz band. For instance, the 2T pulse of CCIR 17 has visible pre- and post-undershoots, but they are not significant enough to impair measurement results. In signals with a rise time of 100 ns (eg 250-kHz, 15-kHz squarewave signals) components outside the nominal VF bandwidth are considerably greater and cause a transient response with pre- and post-ringing of approx. 3%.

For some years, digital signal processing has not only made advances in studio equipment but also in TV measurements. The advantage of this technique is that no components outside the defined bandwidth can occur at the CCIR sampling rate of 13.5 MHz. CCIR specifies a bandwidth of 5.75 MHz for studio equipment. Of course, in test signal generation this bandwidth may be slightly widened but a value of half the sampling frequency cannot however be attained. For this reason R&S generators are equipped with an elaborate lowpass filter of extremely flat amplitude frequency response and a minimum group delay in a passband up to 6 MHz and a very steep drop of amplitude frequency response towards the stopband range (min. 65 dB at 7.5 MHz).

With the aid of these filters non-obsolescent signals can be generated. The extended 6-MHz bandwidth of these signals allows measurements within the limits specified by CCIR REC 601 without any downsampling effects.

If, on the other hand, the bandwidth of broadband signals, eg of a 10-MHz signal, is to be limited, a complex filter has to be connected externally to the generator output. This means either extremely high development costs or, if a filter of the required quality is already available, high extra costs for the instrument.

The conventional method used up to now for measuring the 250-kHz/100-ns transient response with ODFA and an appropriate graticule or tolerance mask still has a some importance considering that many older signal generators are able to

generate 100-ns signal edges, but not the new, complex test signals, which provide much more information, as are produced by state-of-the-art digital signal generators.

- Multipulse: The signal contains three signal elements for various measurement tasks:

1)	Luminance bar:	white level
2)	2T pulse:	reflection and group delay indication
3)	Sin^2 pulses modulated with 1, 2, 3, 4, 5 MHz	frequency response and group delay at the specified frequencies

- Horizontal sweep, 5.5 - 0 - 5.5 MHz, evaluation on oscilloscope

  A pure amplitude frequency response generates an envelope curve symmetrical to the line centre; if group delay occurs, the envelope curve in the areas with a group delay is not symmetrical to the line centre.

  The frequency response can be accurately measured with a spectrum analyzer or the frequency response plus group delay exactly determined by means of FFT.

- sin.x/x:

  This signal cannot be evaluated on the oscilloscope except for the unsymmetrical pre- and post-undershoots which indicate a group delay but not its magnitude. Frequency response and group delay response can only be measured with special FFT analyzers.

- Zone plate

  With the aid of variable zone-plate signals (eg ZONE PLATE signal group in the SAF/SFF) not only periodic test patterns, as are used for measuring amplitude and group-delay frequency response, can be generated. All

horizontal, vertical and time frequency components within the standard can be generated as well. In this case, too, the 6-MHz video bandwidth is fully sufficient for exactly identifying and measuring all impairing effects as may occur in analog or digital signal processing.

Consequently all parameters of a zone-plate signal must be freely programmable. Requirements cannot be met by fixed parameter sets. With a freely programmable zone-plate signal even the most obscure faults in signal processing can be detected. Zone-plate signals can be generated with the new CCVS Generators SAF and SFF from R&S.

In the foreseeable future, the new test signals will replace older test methods like group-delay adjustment using a 250-kHz/100-ns squarewave signal and graticules and masks, since the new signals which allow for a more effective evaluation are already produced today by a great number of digital generators.

Broadband signals are not generally better than band-limited signals, provided the latter are limited with a flat amplitude and group-delay response. The advantage may even be on the side of band-limited signals as can be seen in the example below:

The 250-kHz squarewave signal with a rise time of 100 ns generated by digital signal generators in the frequency range up to 6 MHz is suitable (inspite of its ringing) for the usual measurement on TV transmitters - ie fine adjustment of equalizer delay - just like any squarewave signal without visible ringing from an analog generator.

The reason for this is obvious. The TV transmitter or TV transposer limits the video signal to 5 MHz (standard I: 5.5 MHz, standard D/K: 6 MHz). Signal components above 6 MHz are not applied to the output. Shape and magnitude of the ringing are the result of distortions in the range from 0 to 5 MHz (5.5 MHz; 6 MHz). In this case it makes no difference whether the input signal is limited to 6 MHz when generated or not. On the contrary: By comparing an "ideally" band-limited signal from one of the latest R&S generators with the transmitter output signal, quality assessment can be optimized.