

# Frequency Response Measurements

Jan. 26, 1998

IEEE G-2.1.4

## Objective

- identify limitations in the accuracy of frequency response measurements
- possible improvements to existing methods
- investigate new methods

## Need for better accuracy:

The ITU-R BT.601 Annex 1 mentions:

“ The pass-band tolerances for the amplitude ripple and group delay are recognized to be very tight. Present studies indicates that it is necessary so that a significant number of coding and decoding operations in cascade may be carried out without sacrifice of the potentially high quality of the 4:2:2 coding standard. Due to limitations in the performance of currently available measuring equipment, manufacturers may have difficulty in economically verifying compliance with the tolerances of individual filters on a production basis. Nevertheless, it is possible to design filters so that the specified characteristics are met in practice, and manufacturers are required to make any effort in the production environment to align each filter to meet the given templates.”

Figure 3A-b shows the template for the pass band ripple tolerance of a luminance filter complying to the ITU-R BT.601.

Users, engaged in integrating digital routers and processing equipment within their analog plant, need D/A converters having a frequency response performance accuracy of  $\pm 0.1$  dB between 0 and 6 MHz, in the case of digital composite signals. As multipasses will be made through the same device, frequency response deviations are compounded. Users need procedure and tool to measure contemplated products. The measurement device accuracy should be better than 0.05

## Measurement equipment accuracy and errors:

- Waveform monitor (WFM- 1780R):

Equipment accuracy: Channel A, from 50 kHz to 10 MHz,  $\pm 1\%$ , ( $\pm 0.087$  dB)

Reading error: maximum of 1 div. over 140 div., ( $\pm 0.062$  dB)

The actual measurement accuracy is  $\pm 0.149$  dB.

- Automatic measurement set (VM-700T):

Multiburst function, from 0.5 to 4.1 MHz,

Absolute mode accuracy:  $\pm 0.1$  dB

Relative mode accuracy:  $\pm 0.03$

**Measurement example:**

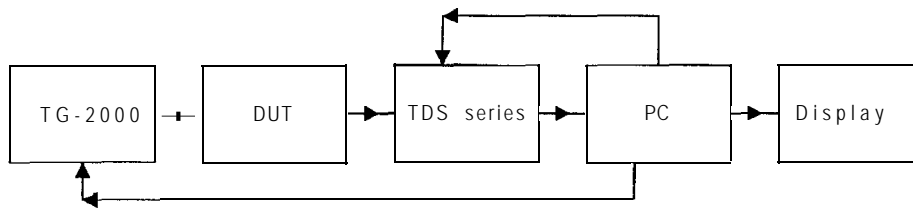
	0.5	1	2	4	4.8	5.8 MHz
WFM-1780 - TPG out	0.00	0.00	-0.00	-0.06	-0.06	-0.12 dB
DUT out	0.00	0.00	0.00	-0.06	-0.12	-0.12 dB
<hr/>						
VM-700T						
Absolute mode - TPG out	0.00	0.23	0.2	0.21	0.18	-0.25 dB
Absolute mode - DUT out	0.00	0.23	0.19	0.2	0.18	-0.23 dB
Relative mode - DUT out	0.00	0.00	-0.01	-0.01	0.00	0.02 dB

**New methods**

One possible solution has been developed by Miranda Technology, in Montreal. This measurement method is completely automated. A block diagram is shown below.

The TDS oscilloscope is used to digitize signals. The computer processes digital signals using an FFT algorithm. A calibration is made by measuring 27 points between 0 and 6 MHz at the TG-2000 output to eliminate ripple in the output signal response.

After calibration, a measurement accuracy of +/- 0.02 dB is achieved.

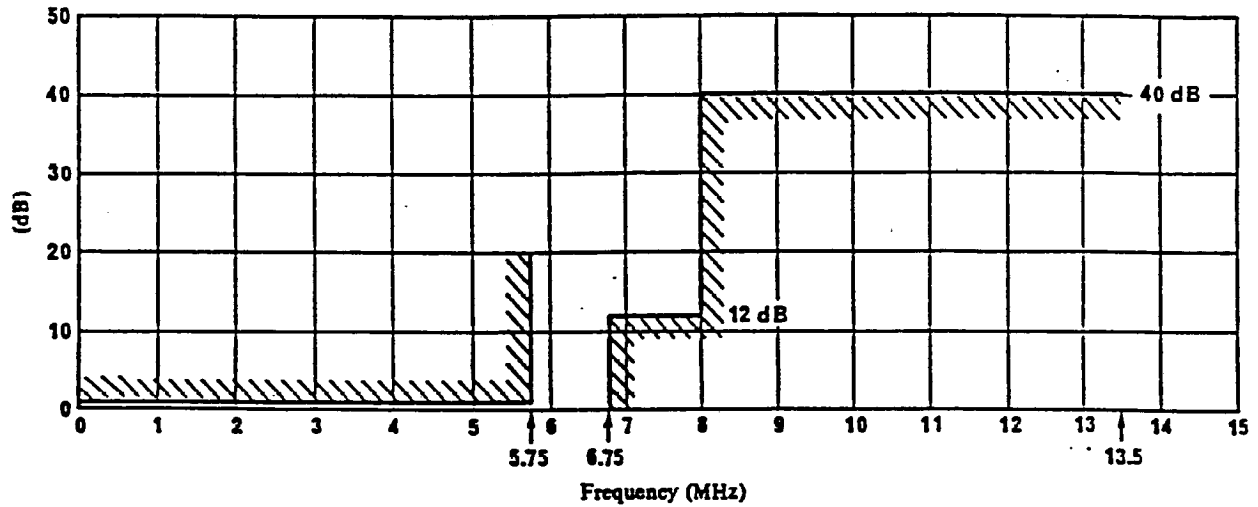


Michael Poulin  
Senior QA Engineer  
Leitch Technology

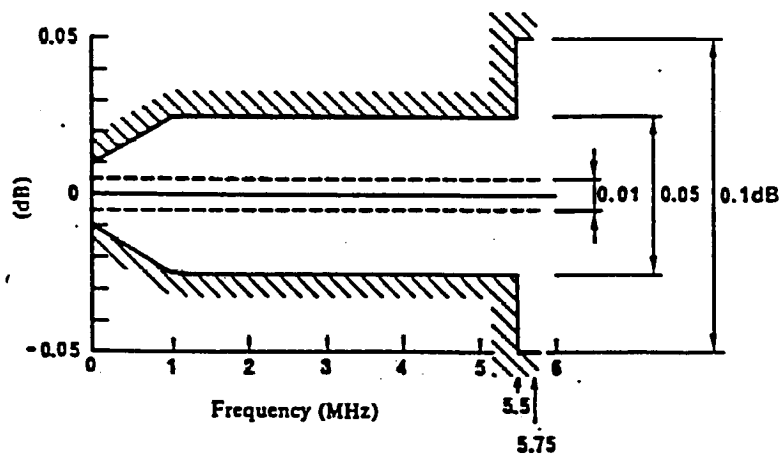
Filtering characteristics

FIGURE 3A

Specification for a luminance or RGB signal filter  
used when sampling at 13.5 MHz



a) Template for insertion loss/frequency characteristic



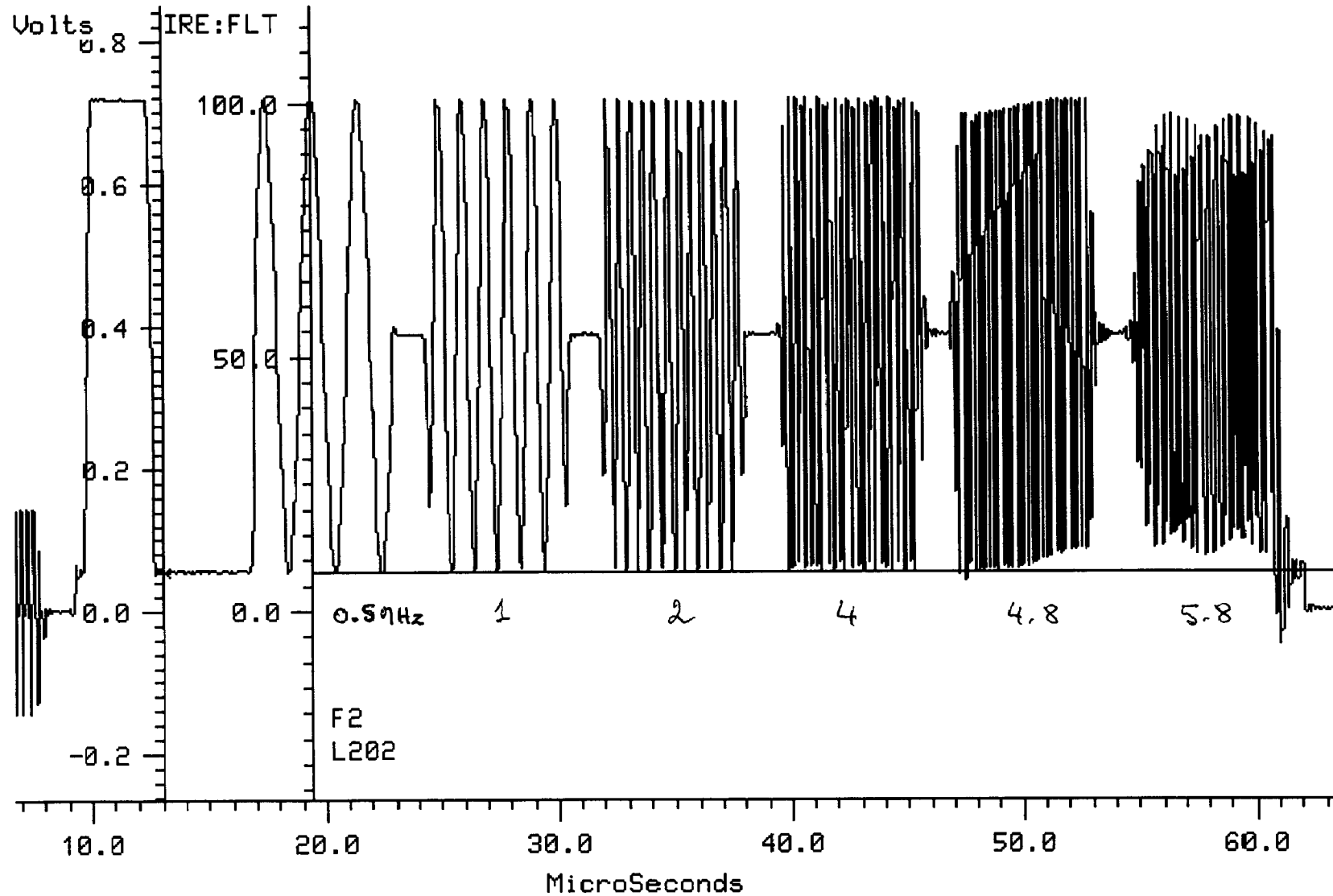
b) Passband ripple tolerance

TPG 20

UM700T Video Measurement Set

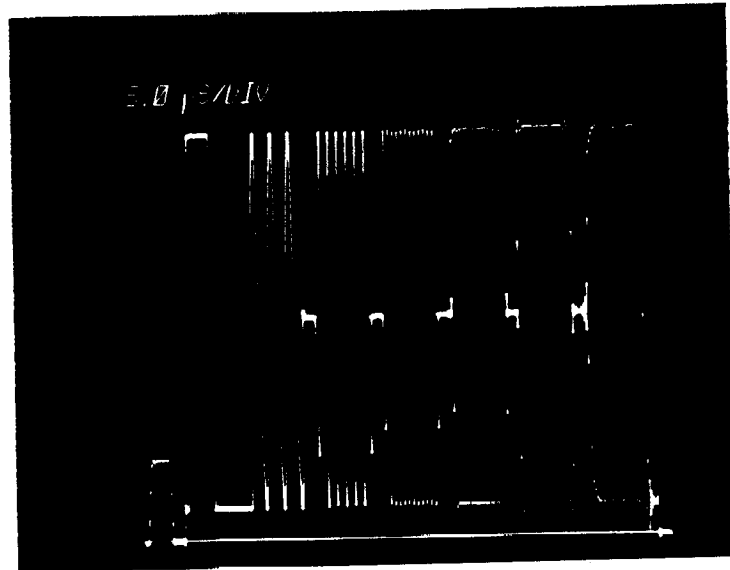
Channel A System Default

23-Jan-98 11:53:03



APL = 51.8%  
525 line NTSC No Filtering  
Slow clamp to 0.00 V at 6.63 us

Precision Mode Off  
Synchronous Sync = Source  
Frames selected: 1 2



TPG Output - Frequency bursts of 0.5, 1, 2, 4, 4.8, 5.8 MHz