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Methods for the measurement of characteristics of CCD cameras

Supplement 1

16:9 format

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Methods for the measurement of characteristics of CCD cameras in the 16:9 format

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Introduction

Broadcast type CCD cameras for the 16:9 image format are now available with different sensor configurations. Furthermore, to the best of knowledge of experts in this field, all modern (wide screen) cameras have switchable aspect ratio in one form or another.

The three types of sensors in use today are:

1) Sensors where the image height is changed between formats (FT sensors) [1]
2) IT and FIT[2] sensors where the CCD horizontal clock frequency is changed, and picture information used only from those pixels in the central part of the image
3) IT and FIT sensors where all the information is read out, and in subsequent digital processing the aspect ratio is changed, and picture information only used from those pixels in the central part of the image.

Most of the measurement methods described in EBU document Tech. 3281 [1] can easily be adapted to the 16:9 formats. Modern CCD cameras have a high horizontal resolution corresponding to video bandwidths close to 10MHz. When these cameras are used in a digital environment it must be remembered that the SDI outputs from the cameras are limited in bandwidth by the filters of the digital studio encoding specification, Recommendation ITU-R BT.601 [2]. Measurements of camera performance must be made at a point in the signal chain where this bandwidth limitation is not yet introduced. In order to avoid any misunderstanding of test results, the necessary test cards must have the true 16:9 aspect ratio.

This supplement includes specialist comments and adaptations of the specifications and values of parameters are given in the main document.

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[1] FT – Frame Transfer

[2] IT – Interline Transfer
FIT – Frame Interline Transfer

Chapter 1
Cameras having sensors with variable pixel size

The switchable FT sensor has the ability to rearrange the pixel size dynamically in the vertical direction. As the number of pixels/line is kept constant the image aspect ratio is thereby changed.

This type of sensor is basically a 4:3 sensor and switching to 16:9 will reduce the line "thickness" (vertical dimension) and thereby the height of the active sensor area. Since the image width is kept unchanged, the horizontal angle of view is also unchanged when switching between 4:3 and 16:9 aspect ratios. This means that the camera lens will give the same horizontal angle of view in both formats.

During measurements, the procedures will remain the same as described in Tech. 3281. It should be observed, however, that the sensitivity will be slightly changed when changing between formats due to the slight change in pixel size. This change is not likely to be significant.

Table 1 gives the dimensions of the various sensor formats for both aspect ratios used in broadcast cameras [3].

Table 1 - Dimensions of CCD television camera sensors

Sensor size (inches)	Sensor size (mm)	Image height (mm)	Image width (mm)	Image diagonal (mm)
4:3 aspect ratio				
2/3	18	6.60	8.80	11.00
1/2	13	4.80	6.40	8.00
16:9 aspect ratio				
1[3]	25	7.84	13.94	16.00
2/3	18	5.39	9.59	11.00

[3] High Definition CCD cameras only

Chapter 2
Cameras having sensors with variable CCD clock frequency

Ccameras using these sensors are not of the most recent types and have analogue signal processing. But these cameras are still in use today. The sensors themselves have IT/FIT structure and these CCDs have a fixed pixel size/structure and an image aspect ratio of 16:9.

When the picture format is changed from 16:9 to 4:3 the CCD horizontal clock frequency is changed. The picture information is only used from that central part of the image which gives the desired the 4:3 aspect ratio (the image height of the sensor is fixed).

The effect of this is that the horizontal angle of view is reduced. Many users will prefer to have the same maximum angle of view for both formats. For this reason the lens manufacturers have developed lenses with so-called “minifiers” in the range extender turret. This (optional) device reduces the focal length in the same proportion as the used image width of the sensor is reduced, thereby restoring the horizontal angle of view. In this case it may also be worthwhile to check if the image enhancement settings need readjustment.

Chapter 3
Cameras with 16:9 sensors and digital aspect ratio converters

The cameras in this category all have digital processing of the video signal. The sensors have 16:9 aspect ratio and all the CCD information is read out. It is in the processing that the change in aspect ratio takes place, but picture information only used from those pixels in the central part of the image. In the same way as described in chapter 2, the horizontal viewing angle is reduced when switching to 4:3 picture format. An optional “minifier” in the lens will restore the viewing angle.

It should be observed that the image diagonal of a 16:9 format sensor is the same as for the 4:3 image format. However, the image heights and widths are slightly different in the two formats as shown in Table 1 and Figure 1. In principle this would mean that lens aberrations present only in the corner areas in a 4:3 image, could be visible at the edges of the image in the 16:9 format. However, as pointed out in the EBU specification of lenses [3- page 14] this is not expected to introduce any negative effect on picture quality.

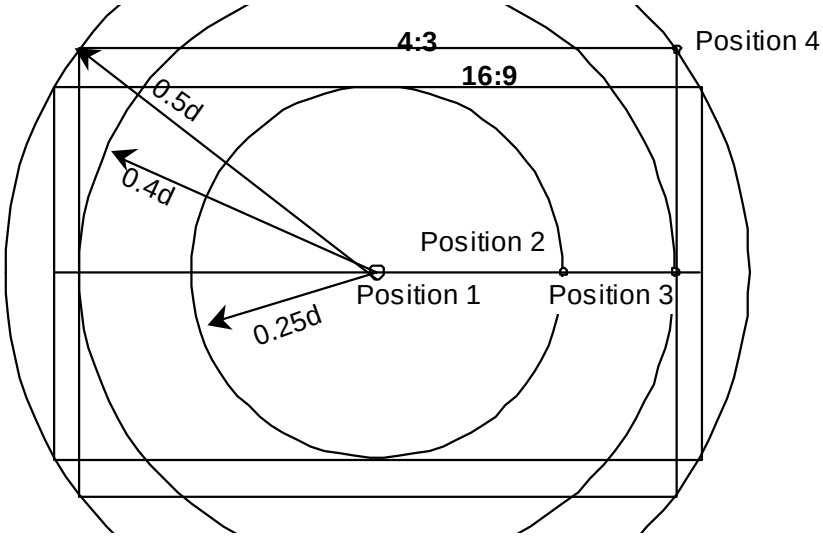

Figure 1: - Image formats and measurement positions

Bibliography

[1] EBU document Tech. 3281-1995: **Methods of measurement of the characteristics of CCD cameras**

[2] ITU-R Recommendation BT.601-5: **Studio encoding parameters of digital television for standard 4:3 and widescreen 16:9 aspect ratios**

[3] EBU document Tech. 3249-1995: **Measurement and analysis of the performance of film and television camera lenses**