Offsets in back focal distances for television cameras with CCD sensors

July 2002

EBU·UER

Contents

1. Introduction 1
2. Offset characteristics 1
2.1 625-line cameras 1
2.1.1 2/3-inch format 1
2.1.2 1/2-inch format for broadcast use 2
2.2 HDTV cameras 2
3. Verification 3
3.1 Measurement method 3
3.2 Measurement conditions 3
3.2.1 625-line cameras 3
3.2.2 HDTV cameras 3
Bibliography 5

1. Introduction

The introduction of CCD cameras some years ago brought with it a change in camera design in the sense that the sensors are cemented to the surface of the beam-splitter. This means that, unlike the situation in tube-type cameras, it is not possible to adjust the back focal distance in CCD cameras.

To accommodate this situation, lenses will have to be manufactured to very tight tolerances, taking account of the properties of the glass material used in the beam-splitter block. However, during the development of CCD cameras, at least two different glass materials are in use for the manufacture of beam-splitters.

In order to achieve interchangeability of lenses between cameras using different prism designs, the manufacturers have reached agreement concerning the positions of the red and blue image planes relative to the green image place. Two de facto standards have emerged, one for the 2/3-inch CCD format, the other for the 1/2-inch format.

2. Offset characteristics

2.1 625-line cameras

The specifications have been established for the 4:3 aspect ratio. As 16:9 625-line cameras will generally use the same lenses as 4:3 ones, the same axial offsets can be used.

2.1.1 2/3-inch format

The details of the camera/lens interface for cameras with 2/3-inch sensors are as follows:

Glass material used for prism		BPG2	F5
Focal point:	Green channel (G) (Flange focal length in air)	48 mm	48 mm
	Red channel	G + 26,5 microns	G + 4 microns
	Blue channel	G - 6,5 microns	G + 30 microns
Prism block thickness		33,5 mm	30 mm
Thickness of filters (and other elements), with BK7 glass material		12,7 mm	16,2 mm
Total glass length		46,2 mm	46,2 mm

2.1.2 1/2-inch format for broadcast use

The industry has specified a lens/camera interface for 1/2-inch CCD format. The specification is given for a particular lens setting but is such that the lens manufacturer retains as much freedom as possible to optimize the performance at other lens settings.

The details of the lens/camera interface for cameras with 1/2-inch sensors are as follows:

Glass material used for prism		F5
	Green channel (G) (Flange focal length in air)	35,74 mm
Focal point:	Red channel	G + 10 microns
	Blue channel	G + 10 microns
Prism block thickness		29 mm
Thickness of filters (and other elements), with BK7 glass material		11 mm
Total glass length		40,0 mm

2.2 HDTV cameras

For HDTV image formats, the lens/camera interface details are as follows:

		CCD image format	
		1 inch	**2/3-inch**
Glass material used for prism		LaK14	BAF 52
Flange focal length in air	Green channel (G)	68 mm	48 mm
Focal point	Red channel	G + 30 microns	G + 10 microns
	Blue channel	G + 10 microns	G + 5 microns
Prism block thickness		50 mm	33 mm
Thickness of filters (and other elements) with BK7 glass material		19 mm	13,2 mm
Total glass length		69,0 mm	46,2 mm

3. Verification

The following measurement procedures are used to verify conformity with the above specifications.

3.1 Measurement method

The method involves the scanning of the image of a 5 MHz square-wave pattern with a narrow slit, with the aim of finding the largest depth of modulation as a function of the back focus.

3.2 Measurement conditions

3.2.1 625-line cameras

The value of back focus differences depends on the overall energy distribution (including illumination), filtering and sensor characteristics) in the three channels. The following equipment characteristics are used to verify conformity with the specification (see also [1]):

Sensor response: photopic eye response (type S20 photocathode)

Colour temperature: *3200 K*

Filters in the three channels:

Red channel:	Corning 2-73 (1,5 mm) + Corning 4-97 (3 mm)
Green channel:	Schott VG9 (1,5 mm) + Schott GG495 (3 mm)
Blue channel:	Corning 3-74 (3 mm) + Corning 5-59 (3 mm)

Lens settings:

Aperture:	maximum
Focal length:	minimum
Object distance	3 m

3.2.2 HDTV cameras

The conditions for measurements on HDTV cameras are the same as for 625-line cameras (Section 3.2.1), except for the filter characteristics. For the 1-inch CCD format, the filter characteristics are as follows:

Filters in the three channels:

Red	Hoya 0-58 (t=1.0 mm)	+	Short wavelength cut off dichroic coating (λ 1/2 = 580 nm)	+	long wavelength cut off dichroic coating (λ 1/2 = 665 nm)
Green	Hoya Y-50 (t=1.0 mm)	+	Hoya G533(t=0.8 mm)	+	long wavelength cut off dichroic coating (λ 1/2 = 580 nm)
Blue	Hoya L-4 (t=1.0 mm)	+	Hoya B440(t=2.0 mm)	+	long wavelength cut off dichroic coating (λ 1/2 = 490 nm)

A set of spectral curves and peak wavelengths has been specified (Fig. 1). These curves include the effect of light source, filters and detectors. They do not relate to the colorimetric characteristics of HDTV cameras.

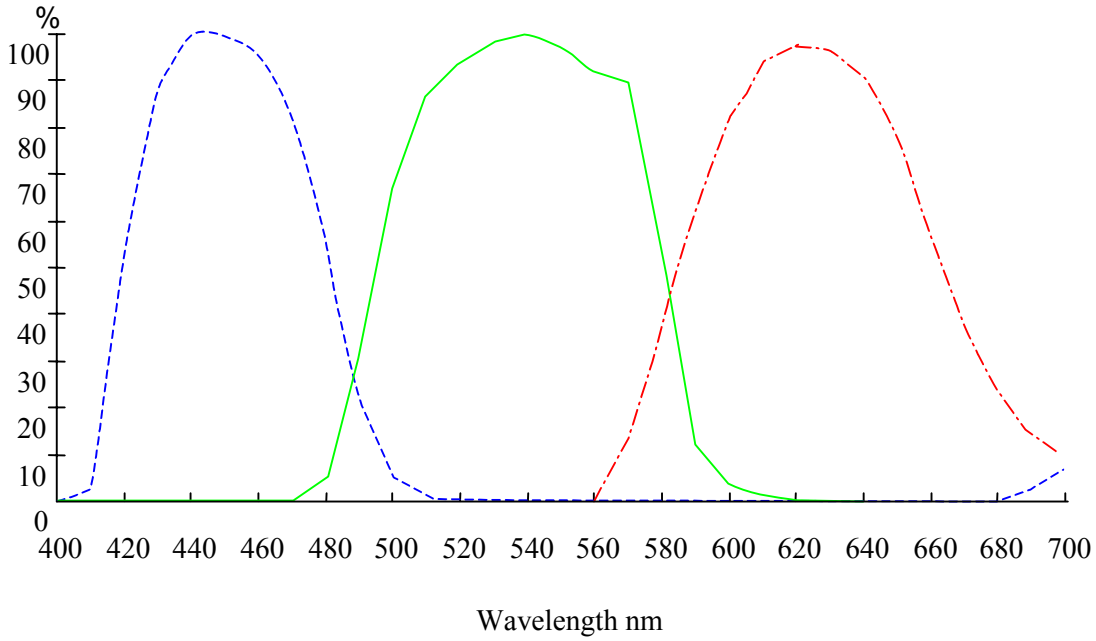

Fig. 1 Filters for HDTV

Bibliography

[1] EBU document Tech 3249 (1995): **Measurement and analysis of the performance of film and television camera lenses**