EBU Technical Recommendation R23-2002
Procedure for the operational alignment of grade-1 colour picture monitors

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Grade-1 monitors are high-quality monitors that may be used under controlled ambient lighting conditions for the alignment and monitoring of programme sources in both studios and outside-broadcast environments. The Specification of Grade-1 monitors is given in EBU document Tech. 3263 [1].

the EBU recommends:

that the alignment procedure for these monitors should be carried out in accordance with the operational sequence described below in order that colour monitors shall display images that reflect as accurately as possible the quality of picture signals produced in accordance with the ITU-R PAL and SECAM standards.

General

The order of adjustment shown below is intended to minimise interactions between one adjustment and another. However, it may sometimes prove necessary to return to an earlier adjustment to verify the correct performance of the equipment as a whole.

Colour monitors considered are those fitted with delta-gun tubes.

1. Purity

To adjust the purity, three colour primary signals which correspond to a uniform white or grey picture are used.

The screen is first scanned with the red beam only. [1] The two purity controls (magnetic rings) are set to obtain a uniform red field of adequate purity as judged by the eye. If rotation of the magnetic rings is insufficient to give an optimum adjustment of the purity, this adjustment may be supplemented by the following operations: the scanning coil assembly is pulled backwards and the purity rings are set to give a red spot at the centre of the screen (this adjusts for the correct inherent beam orientation) and then the assembly is advanced until the entire screen is covered (thus setting the position of the beam deflection zone). The adjustment is then checked on the green and blue fields or on all three primaries together.

A more critical evaluation of the purity can be made by examining the beam landing using an optical magnifier and an incident light source.

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[1] The eye is more sensitive to red when evaluating any variation in shade.

2. Size, centring, linearity, geometry, focus and convergence

The test signal is an electronically-produced grid having 14 horizontal lines and 19 vertical lines (14/19 grid). [2]

For the first four adjustments, the test signal is applied only to the green channel. The later adjustment of the convergence should enable the red and blue images to be superimposed over the green.

The correct picture size is obtained by adjusting the height and width so that the four corners arc visible and so that the aspect ratio is correct. The picture centring is adjusted next.

The correct geometry and linearity are obtained by adjustment of the pin-cushion correction and scan linearity controls so that the picture appears satisfactory when seen from the normal viewing distance. For more accurate adjustments, a special slide can be projected onto the face of the tube, the electronic grid displayed on the tube then being adjusted to match the projected image.

The focus control, [3] which acts simultaneously on all three beams, should be adjusted to give the best resolution of the line structure in the brightest areas of the picture without causing any noticeable loss of resolution in the corners (the focus must not be adjusted at low beam currents). The focus setting may be deferred to the end of the complete operational sequence when the equipment needs only a very small adjustment.

For adjustment of the convergence, the grid is fed to the red and green channels. [4] The convergence currents are first set to give convergence on a central vertical line and then on a central horizontal line; any residual errors are spaced equally on either side of these lines. The blue convergence is then adjusted to give an optimum superimposition of the blue on the red. The result is checked with all three colours and final adjustments are made if necessary.

3. Saturation

When the saturation is adjusted separately, it is done at this stage i.e., before the setting of the black level because, in most cases, it involves a change of the brightness control. However, it may be left until the end of the sequence of operations if it is integrated within other adjustments such as those of the decoder, for example.

For the adjustment of the saturation, a signal is used comprising colour bars of 100% amplitude (100/0/100/0) or 75% amplitude (100/0/75/0) in the standard format.

The blue channel is selected. The brightness is reduced and the saturation control is adjusted so that, whatever the brightness level may be, the visible blue bands (four bands are to be considered in the case of a 100% test signal and three bands in the case of a 75% test signal) appear the same. The brightness control is returned to its original position and it is checked that the black areas are equally black.

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2 Observation of the deformation of squares is easier than that of rectangles and it is generally believed that a small number of squares allows for a better assessment of variations in deformations over the width of the screen.

3 For this parameter, an optical test card (such as BBC test card F) may also be used, instead of the electronic grid.

4 The convergence controls are generally arranged so that the lines of the grid are shifted simultaneously (in opposite directions) for the red and green beams whilst the blue lines can be shifted independently.

This procedure is repeated for the other two channels.

4. Black level, white level, colour balance and grey-scale tracking

These various adjustments are very dependent on the viewing conditions and it is preferable to conform to the conditions contained in ITU-R Recommendation BT.500 [2].

4.1 Subjective assessment

For visual assessment of brightness, contrast and chromaticity of white, and adjustment of the pertinent monitor controls, the PLUGE signal, as specified in Fig. 1, is used

The optical equipment needed comprises a photometer and an optical comparator (giving D65 reference light) which should preferably have an adjustable iris.

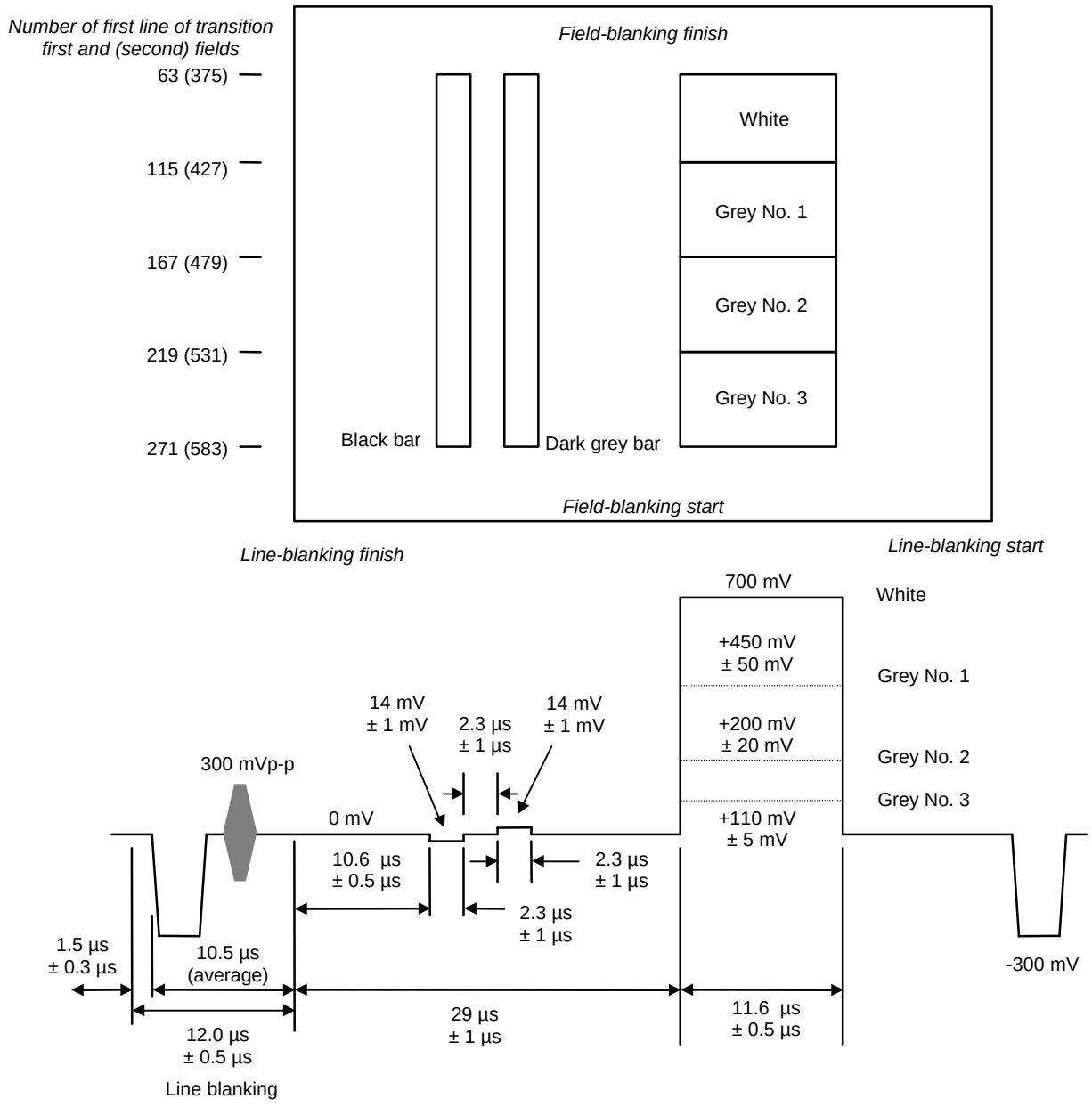

Fig. 1 - Recommended waveform for PLUGE signal

The following adjustments should be made under the operational lighting conditions.

a) The brightness control is set so that the blackest area (-2% video level) just disappears whilst the dark grey area (+2%) remains clearly visible. This setting shall correspond to the pre-set brightness control position.

b) Using the photometer, the contrast is adjusted until the centre of the white area (100% video level) has a luminosity of about 80 cd/m2 (25 fL). This setting shall correspond to the pre-set contrast control position.

c) The iris of the optical comparator is adjusted to give the same luminosity as the white area in the displayed image and the gains of the red, green and blue channels are adjusted so as to match the white area to the D65 reference light.

d) The adjustment at low luminance levels will be made by adjusting the iris of the optical comparator so as to obtain a luminosity equal to that of the grey area No. 3. Then the black level controls of the blue and red channels are adjusted to match the colour of this field to that of the optical comparator.

e) Before a result that is entirely satisfactory is obtained, the procedure described above will usually be repeated so as to reduce, as far as possible, effects of interactions between the various controls. [5]

f) Additionally, the grey scale tracking may be checked by using the optical comparator to examine the intermediate grey areas Nos. 1 and 2.

A very critical check of the grey scale tracking can also be made using a monochrome signal displaying a moving picture with the colour burst present.

4.2 Objective assessment

For this assessment the colour of the display is measured and matched at white level (100% video level) and at a dark grey level corresponding to a video level of about 15%.

The measurement equipment needed is either a colorimeter or a colour analyser to measure the colour and the luminosity.

The recommended routine is as follows:

a) Incident light is eliminated.

b) The brightness and contrast controls are set to their pre-set positions.

c) The dark grey signal (about 15% video level) is applied and the black level controls of the red, green and blue channels are adjusted to achieve colour balance for D65.

d) The white signal (100% video level) is applied and the gain controls of the red, green and blue channels are adjusted to achieve the luminosity of 80 cd/m2 and colour balance for D65.

e) Under the operational lighting condition, the brightness control is set (variable position) with the aid of the PLUGE signal as described in Section 4.1.a.).

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5 The luminosity corresponding to the “dark grey signal" must be adjusted subjectively, as in the described procedure, because its value depends on the ambient light.

Before a result that is entirely satisfactory is obtained, the adjustments described in items c) and d) will usually have to be repeated so as to reduce, as far as possible, effects of interactions between the various controls.

4.3 Automatic and other methods

Automatic and other methods which compensate for the ambient light are suitable, provided that equivalent results are obtained. [2].

Bibliography

[1] EBU Tech 3263 (2nd edition, 1996): **Specification of grade-1 colour picture monitors**

[2] ITU-R Recommendation BT.500-5: **Method for the subjective assessment of the quality of television pictures**