Monitor Brightness, Contrast and Colour Calibration
A Practical Guide

Before a monitor is **White Balanced** it is recommended to make the following checks (depending on screen type):

- Purity using a Red field
- Convergency check

All colours that appear on the screen of a colour TV are composed by the addition of three primary colours: Red, Green and Blue. By controlling the driving voltage of three electron guns in the CRT, the intensities of the three colours can be controlled and thus various colours can be reproduced. However, when video signals are demodulated to RGB and before they are fed to the electron guns, the signal passes through amplifiers. We have to adjust the gain and the set-up of the amplifiers to make sure the TV set will reproduce the correct colours. This corresponds to adjustment of cut-off, contrast and white balance. When these has been adjusted also the chroma gain needs adjustment in composite systems.

Figure 1 shows the colour performance of a monitor before alignment. At both low and high intensities the brightness of red is higher than blue. Thus the monitor is biased to a reddish display. This is more serious in the low intensity range as the relative amount of red error here is much larger.

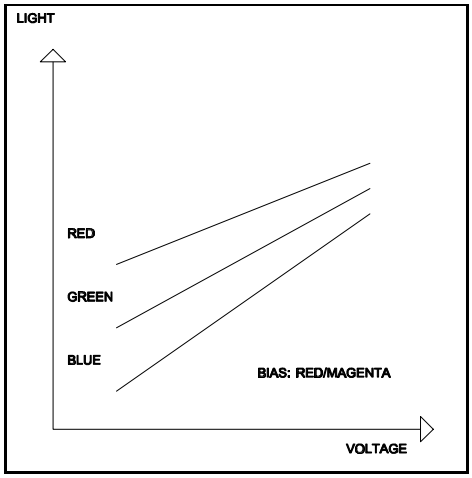


Figure 1

Figure 2 shows a monitor biased to cyan at high intensities and to red in low intensity display.

It is essential to adjust the offset (difference in the low end) and gain (slope) of the three electron guns such that the monitor reproduces the correct colours. This procedure is called **White Balance Testing** or **White Balance Adjustment**.

In the past human judgement was the only way to calibrate a monitor. Human judgement is subjective, and not very reliable and reproducible since the response is influenced by a number of things, such as emotion, health conditions etc. Therefore affordable instruments to give us objective and reliable colour/light adjustments is needed.

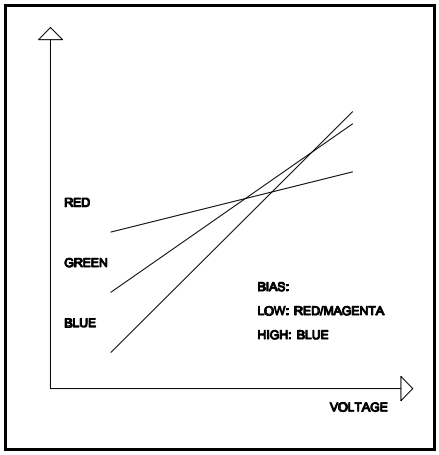


Figure 2

Even when the gain and offset of the three guns are aligned, it may still be found that the monitors perform differently.

In figure 3 the two curves represent the display performance of two monitors, both aligned to the same white reference.

The difference in the low end shows that the brightness of the two monitors is not equal. At higher output the monitors tend to have the same light output. Monitor 1 has less contrast range than monitor 2. When a colourful picture is displayed on the monitors, it will be noticed that the two monitors look different. Colours on Monitor 1 will look pale compared to colours on Monitor 2.

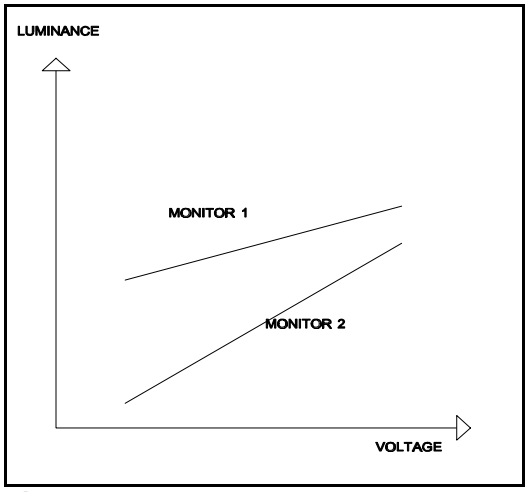


Figure 3

Procedure for the adjustment of monitors to obtain consistent performance:

Apparatus:

Colour Analyser:

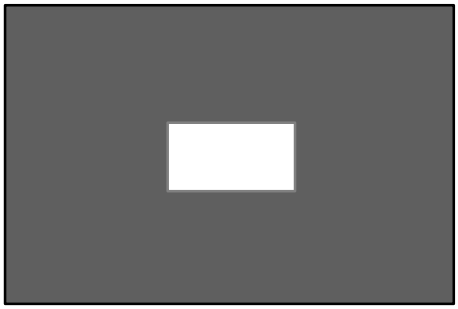
- CRT colour analyser, i.e. PM 5639/00
- LCD Colour analyser

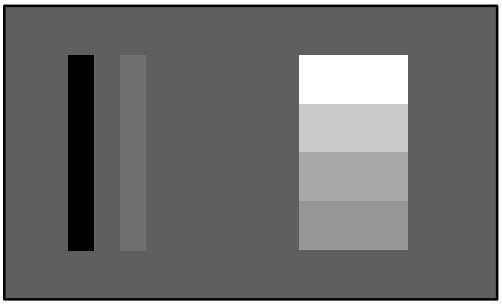
Generator supplying test signals:

- PM5639/82, Component generator
- PM5639/83, Composite generator
- or other suitable generator supplying the below test signals.

For the component drive it is very important that all 3 channels has the same gain.

The generator should provide the PLUGE signal and Window signals of different levels from black (0%) to white (100%) for the black and white adjustments and split field colour bar (colour bar with reverse blue bars for NTSC) for the chroma gain adjustment. If a window generator is not obtainable a flat field generator may be used.





1. **Adjust Black/Cut off Level**

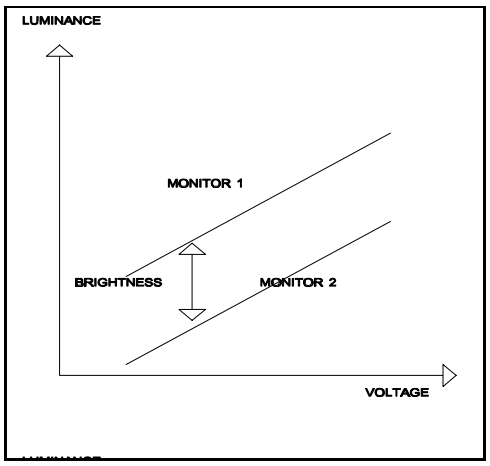


Figure 4

1.1 Adjust the CONTRAST control of the monitor to the middle setting.

1.2 Input PLUGE SIGNAL. Adjust the brightness control so that the blacker than black part of the signal just disappears and the lighter than black part is just visible.
If a PLUGE signal is not accessible, switch between a 0% and a 5% signal. The switching between the signals should be just clearly visible. The brightness of the monitor has now been correctly adjusted to operate at the actual ambient light level.

1.3 Put the colour sensor of the PM 5639 on the CRT. Select CIE xy mode.

2 **Adjust White/Contrast level**

2.1 Input WHITE LEVEL (100%) window or flat field signal.

2.2 Adjust the CONTRAST of the monitor until luminance reading (Y) on PM 5639/00 reaches the user specified value. The value is set by the user and the capability of the monitor, e.g. 100cd/m^2.

The above two procedures determine the overall intensity level at low and high video level.

3 **Adjust WHITE BALANCE**

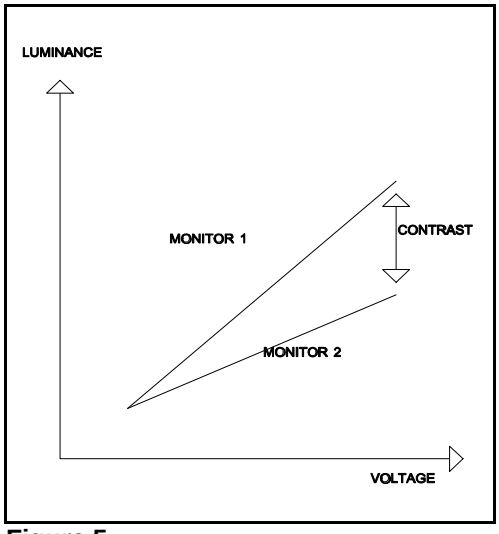


Figure 5

3.1 Input a low level window or flat field signal, e.g. 15% to the monitor.

3.2 Adjust variable controls for low level colour control (R/G/B cut off, depending on the monitor model) until the black dot on the screen of PM 5639 ends up within user's tolerance, e.g. dE = 1-10 units.

3.3 Input high level window or flat field signal, 100% to the monitor.

3.4 Adjust variable controls of high level colour control (R/G/B gain, depending on the monitor model) until the black dot on the screen of PM5639 ends up within user's tolerance.

Repeat procedures 1.2 to 3.5 to fine-tune the adjustments. This is necessary because of the interaction between the adjustments.

If several monitors have to be adjusted to the same setting the procedure should be followed for the first monitor. The remaining monitors may then be adjusted by use of the obtained result on the first monitor.

Perform the following measurement on the reference monitor:

Input a low level window or flat field signal, e.g. 15% to the monitor.

Measure the low level luminance of the screen $\mathbf{L_{LOW}}$.

Input high level window or flat field signal, 100% to the monitor.
Measure the high level luminance of the screen $\mathbf{L_{HIGH}}$.

On the remaining monitors perform this slightly changed procedure:

4.1 Adjust the CONTRAST control of the monitor to the middle setting.

5.1 Input the low level window or flat field signal to the monitor.

5.2 Adjust the brightness control to obtain the luminance reading $\mathbf{L_{LOW}}$.

5.3 Adjust variable controls for low level colour control (R/G/B cut off, depending on the monitor model) until the black dot on the screen of PM 5639 ends up within user's tolerance, e.g. dE = 1-10 units and the luminance reading shows $\mathbf{L_{LOW}}$.

6.1 Input the high level window or flat field signal to the monitor.

6.2 Adjust the contrast control to obtain the luminance reading $\mathbf{L_{HIGH}}$.

6.3 Adjust variable controls of high level colour control (R/G/B gain, depending on the monitor model) until the black dot on the screen of PM 5639 ends up within user's tolerance and the luminance reading shows $\mathbf{L_{HIGH}}$.

Repeat procedures 5.1 to 6.3 to fine-tune the adjustments. This is necessary because of the interaction between the adjustments.

In some cases happen it may happen that the adjustment in point 5.2-5.3 and 6.2-6.3 cannot be performed or the adjusted controls end up being adjusted far out in one of the directions. If for instance the contrast control is adjusted to one end, this may be counter adjusted by the high level RGB gain controls.

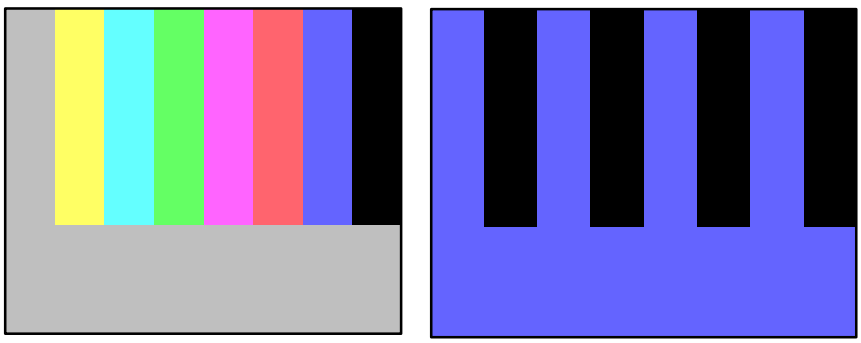
Chroma Gain

The chroma amplitude is responsible for the tracking of the luminance in the colours to the luminance in the black a white signal. This adjustment is performed a little different in PAL and NTSC systems.

Chroma Gain PAL

Select a split-field 75% colour bar with 75% grey for this adjustment. The colour bar is displayed in the top 2/3 of the screen and the grey is shown in the bottom 1/3 of the screen.

Switch off the red and green guns on the monitor. Do not switch off the components on the generator. Adjust the "chroma" or "chroma gain" to make the intensity of the blue in the bottom part of the picture equal to the intensity of the blue bar.



Chroma Gain NTSC

In NTSC systems both the chroma gain and the hue need to be adjusted. Select the SMPTE colour bar with reversed blue bars.

The top of the picture consists of a colour bar, below this a so-called reverse blue bar. In the bottom of the picture there is still another bar consisting of -I, white and +Q signal followed by a black part with PLUGE. The first three signals are not used here. The PLUGE signal is included just below the red bar might be used for the brightness setting.

Select the "blue only" mode on the monitor. Adjust the hue and chroma gain to get equal blue response in the colour bar part and in the reverse blue bar part of the picture.

If large adjustments have been made to optimise the chrome/hue adjustments it might be useful to check the previously executed black and white adjustments.

Check of overall function.

- Check greyscale tracking
- Check High Tension with NEEDLE pulse:
  Control the shape of the needle pulse. Deviation from straight line indicate high tension problems and reduction in resolution. Reduce the contrast or find a better monitor. This is typically a problem with consumer monitors
- Check CRT overload test:
  If the staircase looks like a trumpet the phosphors are overloaded (blooming) and resolution reduced. Turn the contrast down or find a better monitor