Application Note

Improved
Brightness Uniformity

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Summary:

All CRT-Display systems have a certain amount of brightness decrease from centre to sides of the tube. This application note describes an electronic correction method for this phenomena. The circuit consists of a horizontal parabola generator for brightness uniformity correction. The generated parabola is added to the contrast input of a video preamplifier (TDA4882) thus compensating the brightness decrease of a picture tube. The parabola amplitude is optimised for a fixed horizontal frequency and is self-adjusting with the contrast level setting.

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1 Introduction.

In picture tubes the brightness decrease towards the edges of the screen is more and more a discussion point with customers. Especially for monitor applications (e.g. Windows®; full white, single colour) the demand arose for a better brightness uniformity performance.

Usually a brightness decrease limited to 20% (!) is wanted, depending on ambient light conditions and application of the tube (set). When the brightness decrease of the tube is known, it can be corrected by adding brightness correction signals (horizontal and vertical parabola) to the contrast input.

A side effect of brightness correction is that the spot size at the sides (which is already worse then in the centre) is worsened with respect to the spot performance in the centre. Therefore a compromise between compensation factor and spot degradation must be chosen.

The first choice is not to include the vertical brightness decrease. This because the vertical brightness decrease with most picture tubes is already < 15 % and is therefore not as important as the horizontal brightness decrease. When vertical parabola is required the same circuit with different component values can be used, see also ETV/AN93022[1].

With a relatively simple circuit (described in chapter 3) it is possible to generate the required horizontal parabola voltage. Since the application is particularly useful for monitor applications the circuit is designed as an add-on to the Philips advanced monitor video controller TDA488* series which allows HF modulation of the contrast control voltage. The circuit has been tested with the TDA4882. Unfortunately a contrast input is not available on many TV IC’s.

With the horizontal brightness decrease reduced to approximately 15%, the brightness uniformity is excellent with only a minor increase in the spot size towards the side of the screen.

2 Brightness uniformity correction.

The brightness decrease of a 28" 16:9 HR monitor with the tube W67EWS001X21 has been measured at several positions on the screen. The average horizontal (left to right) brightness decrease is approximately 30 %, the average vertical (top to bottom) brightness decrease is approximately 15 % which is regarded as acceptable.

In theory the relation between contrast input (CO_{in}) of the used preamplifier IC (the TDA4882) and cathode drive voltage is linear. Therefore the light output of the picture tube is correlated to the contrast input (CO_{in}) as indicated in equation (1).

$$Light \propto (CO_{in} - 1)^{\gamma} \qquad \textbf{(1)}$$

The TDA4882 is linear between 1 and 6 Volt on the contrast input, see also the datasheet of the TDA4882[2].

With a brightness decrease of 30 % and equation (1) the required modulation for 100% compensation ($Mod_{100\%}$) can be calculated with equation (2). The required parabola voltage (V_{par}) can then be calculated with equation (3) which is linear with the contrast setting.

$$Mod_{100\%} = \sqrt[\gamma]{\frac{1}{0.7}} \qquad \textbf{(2)}$$

$$V_{par_{100\%}} = (CO_{in} - 1) * Mod_{100\%} \qquad \textbf{(3)}$$

With equation (2) and (3) and $\gamma \approx 2.3$ the required modulation for 100% compensation ($Mod_{100\%}$) is approximately 17 % and V_{par} is:

$$V_{par} = (CO_{in} - 1) * 170\ mV \qquad (CO_{in}\ in\ Volt) \qquad \textbf{(4)}$$

With full 100 % compensation the perception of perfect brightness is that the centre of the screen looks dark compared to the sides. Therefore it is not recommended to fully compensate the brightness decrease but only compensate partly (e.g. approximately 50 %, leaving the brightness decrease at approximately 15 %).

3 The parabola generator circuit.

This chapter describes a simple circuit to obtain the required horizontal parabola voltage. The circuit consists of an adjustable block generator followed by two integrators as shown in the block diagram of Figure 1. The circuit is therefore set for one single frequency.

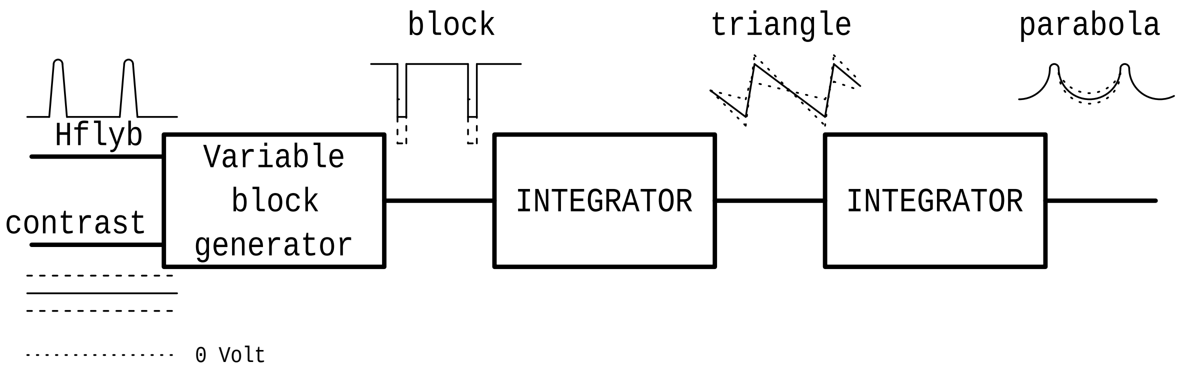

Figure 1 Block diagram of the brightness uniformity correction circuit.

3.1 Circuit description.

In Figure 2 the circuit diagram of the parabola generator is given. The blocks as shown in Figure 1 are realised here.

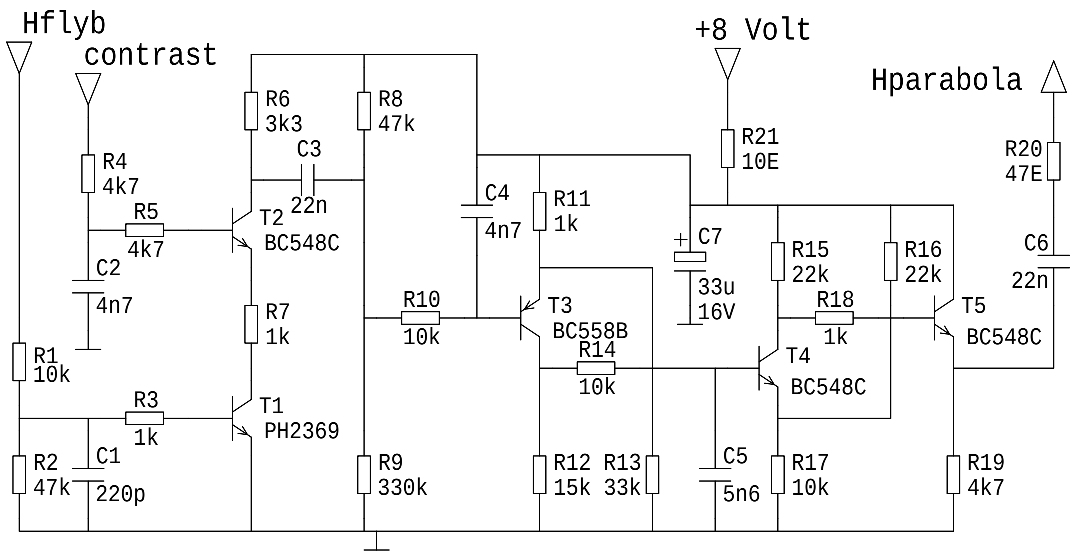

Figure 2 Complete circuit diagram of the brightness uniformity correction circuit.

Power supply:

The circuit is powered from the +8 Volt supply present on the video print through resistor R21. Peak currents will remain local by means of the buffer capacitor C7.

Block waveform generator:

Transistor T1 is driven by the Hflyb voltage. Resistor network R1 and R2 with capacitor C1 make it possible to shift the horizontal parabola with respect to the incoming horizontal flyback pulse (Hflyb).

A series resistor of 10 kΩ must be inserted between the contrast input of the TDA4882 and the current limited contrast setting (see Figure 3). The input to the circuit is taken before the 10 kΩ resistor.

When Hflyb is low, the collector of T2 (output) is +8 Volt. When T1 is driven (Hflyb > 850 mV), the contrast input is buffered, filtered (R4, C2 and R5) and amplified with resistor T2 at a ratio of R6/R7 which results in a block waveform with a duration equal to the horizontal blanking and an amplitude (V_{block}) of:

$$V_{block} = \frac{R6}{R7} * (CO_{in} - V_{beT2} - V_{cesatT1}) \qquad \textbf{(5)}$$

(VbeT2 + VcesatT1) approximates the 1 Volt mentioned in equations (1), (3) and (4).

First integrator:

The resulting contrast dependent block waveform is AC coupled with capacitor C3 into the integrator network formed by resistor R10 and capacitor C4. The biasing is set with resistors R8 and R9. The resulting saw voltage is amplified with transistor T3 by the resistor ratio R12/R11. Resistor R13 is added for correct circuit biasing.

Second integrator and buffer:

The saw voltage is integrated by the integrator network formed by resistor R14 and capacitor C5. The resulting parabola voltage is amplified with transistor T4 by the resistor ratio R15/R17. Resistor R16 is added for correct circuit biasing.

The resulting parabola voltage is buffered with transistor T5. The horizontal parabola voltage is AC coupled via capacitor C6 and resistor R20 to the contrast input (after the 10 kΩ resistor) of the TDA4882, see Figure 3.

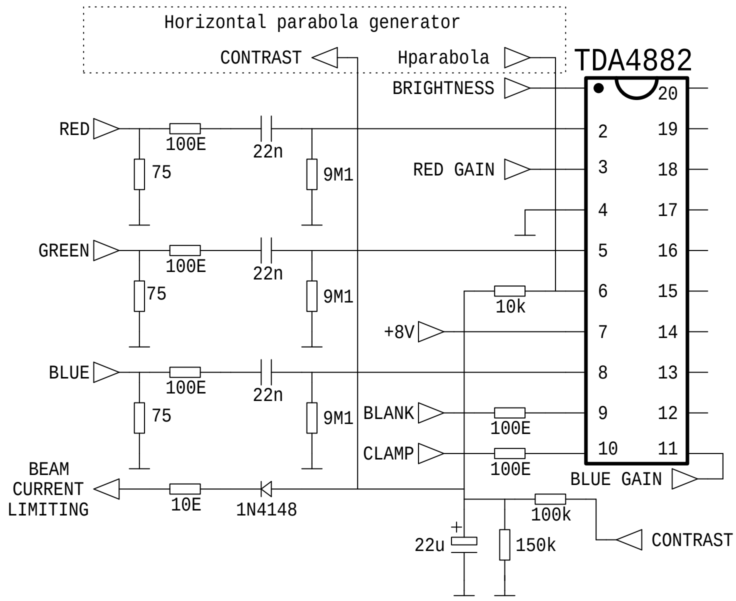

Figure 3 Application of brightness uniformity correction with the TDA4882.

Oscillograms of the horizontal parabola generator measured in a PCALE 16:9 HR-monitor, see also Figure 1.

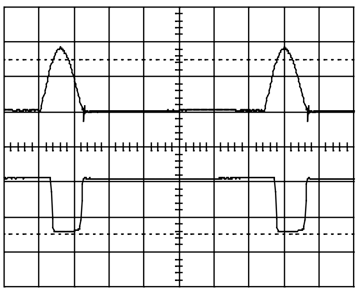

Figure 4 Horizontal flyback generating block waveform

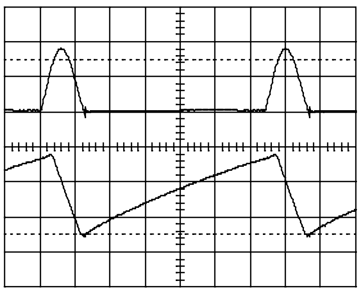

Figure 5 Triangular waveform

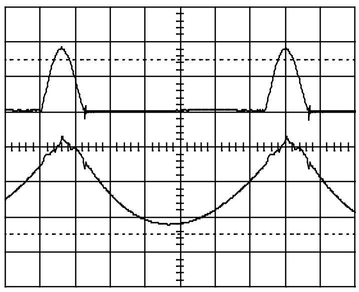

Figure 6 Parabola waveform

Note: The amplitude and frequency of the signals are not indicated in the above figures They can be different for other applications. Figure 4 to Figure 6 were measured is a 32 kHz 16:9 HR monitor.

4 Application hints.

1. The correction amplitude of the horizontal parabola voltage can be adjusted by variation of resistor R15.
2. For different frequencies a new optimal time constant for resistor R10 and capacitor C4 should be found.
3. The output of the circuit can be connected to any video processor with a contrast input that allows fast modulation (at least a bandwidth greater than 10 f_H).

5 Conclusions:

This circuit shown in Figure 2 has been tested in combination with the advanced monitor video controller IC TDA4882 in a PCALE 16:9 HR monitor.

It is possible to obtain 100% brightness uniformity. In practise however, a remnant brightness decrease of 10-15 % is found to be more attractive. In that case the increased spot size (focus deterioration) is hardly visible. The achieved brightness uniformity on the other hand will be significant.

For demonstration purposes a switch was included to switch the brightness correction circuit on and off. To be able to demonstrate the desired effect it appeared necessary to add an extra DC current to the input of the TDA4882 to prevent a brightness decrease in the centre of screen together with an increase at the sides. It is more demonstrative to have a constant brightness in the centre of the screen and then increase the brightness at the sides of the screen.

6 References:

1. ETV/AN93022 25/11/93 — Vertical dynamic focus circuit by J.J.M. Hulshof

2. TDA4882 — Advanced monitor video controller TDA4882 preliminary specification

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