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DISPLAY DEVICE BIAS SYSTEM

5 This invention concerns apparatus for automatically controlling the bias of an image display device in a video processing and display system.

10 Video signal processing and display systems such as television receivers and video monitors sometimes employ an automatic kinescope bias (AKB) control system for automatically maintaining proper black current levels for each electron gun of an associated image displaying kinescope. As a result of this operation, displayed picture colors and gray scale tracking of the kinescope are prevented from being adversely affected by variations of kinescope bias from a desired level due to aging and temperature effects, among other factors. Various types of AKB systems are known, such as are described in U.S. patents 4,263,622 and 4,387,405 for example.

15 An AKB system typically operates during image blanking intervals when the kinescope conducts a small black level representative current. This current is sensed by the AKB system to generate a bias control signal representing the difference between the sensed black current level and a desired black current level, and the control signal is applied to video signal processing circuits with a sense for reducing the difference. In previous AKB systems the kinescope bias is adjusted to the proper level by applying the bias control signal to the video output kinescope driver stage for varying the output bias of the driver stage, and thereby varying the bias of the signal input electrode (e.g., the cathode electrode) of the kinescope such that proper kinescope bias is maintained. Such systems require that the kinescope be DC coupled to the output of the driver stage.

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35 However, AC (capacitive) coupling of a driver stage to a kinescope is often desirable, such as in wideband video monitor systems and in systems where

it is desirable to maintain a substantially fixed DC output bias for the driver stage. AC coupling the driver to the kinescope advantageously permits the working point of the driver stage to be optimized, and allows the use of a lower operating supply voltage for reduced power consumption. The use of a lower operating supply voltage permits the use of a lower value load resistance for the driver stage, which is desirable in wideband video applications. A lower supply voltage also allows the use of inexpensive output transistors without a heatsink, which is particularly advantageous in consumer television receivers.

According to the present invention there is provided a video processing system having a driver amplifier stage, a kinescope and automatic kinescope bias apparatus, in which the video signals from the driver amplifier stage output are AC coupled to the kinescope cathode and the kinescope displays video information in accordance with the signals provided to its cathode, and in which the automatic kinescope bias apparatus automatically maintains the cathode bias of the kinescope in a desired condition and includes means which senses during an image blanking interval the magnitude of the black current conducted by the cathode by applying a cathode-current-enhancing pulse to the kinescope grid while a black level signal is coupled to the cathode and means which responds to the sensed black current and produces a biasing signal related to the magnitude of the sensed black current, which biasing signal is applied to the kinescope cathode.

An embodiment of the present invention, given by way of non-limitative example, will now be described with reference to the accompanying drawings, in which:

1 In the drawing:

FIGURE 1 shows a portion of a television receiver including an AC coupled video output driver stage, and an AKB system in accordance with the present invention;

FIGURE 2 illustrates timing signal waveforms helpful in understanding the operation of the system shown in FIGURE 1; and

FIGURE 3 depicts an alternate form of the arrangement of FIGURE 1.

In FIGURE 1, a video signal such as the red color signal component of a color video signal from a source 10 is amplified by a video output driver amplifier stage 12. Amplifier 12 includes a high voltage transistor 15 with a collector output circuit including series connected load resistors 16 and 18 with different values coupled to a source of operating supply voltage (+150 volts) for transistor 15. A normally non-conductive diode 17 limits excessively large video output signal amplitude excursions during normal image intervals. An amplified video signal developed at the collector output of transistor 15 exhibits a magnitude sufficient to drive an intensity control cathode electrode 22a of a color kinescope 25, and is AC coupled to cathode 22a via a capacitor 20. In this illustration kinescope 25 is of the self-converging "in-line" gun type with a commonly energized grid 24 associated with each of separate cathode electrodes 22a, 22b and 22c. The separate cathode electrodes each form an electron gun assembly of kinescope 25 together with grid 24.

An automatic kinescope bias (AKB) control network 30 operates as a DC restoration network to maintain a desired level of black current conduction for the kinescope electron gun assembly comprising cathode 22a. Similar AKB networks (not shown) are respectively associated with the electron guns comprising cathodes 22b and 22c which receive, e.g., the green and blue color signal components from source 10 in a manner similar to

1 that illustrated for the red signal component. The
operation of AKB network 30 will be described with regard
to the AKB timing signal waveforms shown in FIGURE 2. The
timing signal are generated by a source 40 in response to
5 a horizontal image synchronizing signal H and a vertical
image synchronizing signal V, both derived from deflection
circuits of the receiver.

Referring to FIGURE 2 for the moment, the AKB
operating interval includes a sensing interval which
10 occurs shortly after the end of each video signal vertical
retrace interval within the vertical blanking interval,
during which time video signal image information is
absent. During this time a positive grid drive pulse G
and a positive sensing enable pulse S are generated as
15 shown, each having a duration of approximately one
horizontal image line interval in this example. Also
associated with the AKB operation is a clamping interval
when a clamp keying pulse K is developed, prior to pulses
G and S. A blanking pulse B encompasses the AKB operating
20 interval when pulses K, G and S are developed, and serves
to establish a video signal reference condition during the
AKB operating intervals.

Continuing with FIGURE 1, blanking signal B is
applied to a blanking input terminal of signal source 10
25 to inhibit the video signal output of source 10 during AKB
operating intervals. During each AKB black current
sensing interval, positive grid drive pulse G forward
biases grid 24 of the kinescope, thereby causing the
electron gun assembly comprising cathode 22a and grid 24
30 to increase conduction. In response to pulse G a
similarly phased, positive current pulse is induced at
cathode 22a during the grid pulse interval. The amplitude
of the cathode output current pulse is related to the
level of cathode black current conduction (typically a few
35 microamperes).

The induced cathode output pulse is coupled as a
current pulse P1 of approximately 1 microampere via AC
coupling capacitor 20 to the collector output circuit of

1 transistor 15. Current pulse P1 causes a positive
voltage pulse P2 with a peak-to-peak amplitude of
approximately 1 millivolt to be developed across sensing
resistor 18. Pulse P2 is AC coupled via a capacitor 32 to
5 an inverting operational amplifier 33 with a voltage gain
of approximately 500, so that an amplified, inverted
version of pulse P2, shown as a voltage pulse P3, appears
at the output of amplifier 33. Pulse P3 exhibits a
peak-to-peak amplitude of approximately 0.5 volts with
10 respect to a positive peak pedestal reference level of
+6.0 volts which is stabilized by means of a feedback
clamping circuit.

The feedback clamping circuit includes an
operational transconductance amplifier 34 and capacitor
15 32. Amplifier 34 has an inverting input (-) coupled to a
source of positive reference voltage VR1 (+6.0 volts), a
non-inverting input (+) which is coupled to the output of
amplifier 33, and an output coupled to capacitor 32 at the
inverting input of amplifier 33. Clamping amplifier 34 is
20 keyed to conduct in response to keying signal K, which
immediately precedes the AKB sensing interval encompassed
by pulse S, as shown in FIGURE 2. By feedback action
amplifier 34 modifies the charge on coupling capacitor 32
so as to maintain the positive peak pedestal reference
25 level of signal P3 clamped to 6.0 volts.

Clamped signal P3 is applied to a non-inverting
input (+) of an operational transconductance amplifier 35
which acts as a keyed comparator. A positive reference
voltage VR2 of +5.5 volts in this example is applied to an
30 inverting input (-) of amplifier 35. Amplifier 35 is
keyed to conduct by sense enable pulse S for sensing and
comparing the peak amplitude of black current
representative input signal P3 with input reference
voltage VR2. If the negative-going peak amplitude of
35 signal P3 substantially equals reference voltage VR2, the
output current of amplifier 35 does not change. This
corresponds to a condition of correct kinescope cathode

1 bias wherein the existing bias of the kinescope is not
altered by the AKB system.

As discussed below, network 30 operates to
restore the DC level at cathode 22a via terminal A,
5 thereby establishing the DC bias of cathode 22a, as a
function of the magnitude of signal P3.

The peak negative-going amplitude of signal P3
differs from reference voltage VR2 in accordance with the
amount by which kinescope cathode bias is incorrect.
10 Illustratively, if the amplitude of signal P3 is such that
the output current of amplifier 35 is caused to increase,
a related increase in charge is developed on a storage
capacitor 36. The increased charge on capacitor 36 causes
the conduction of a transistor 37 to increase whereby the
15 current conducted through resistors 38 and 39 increases.
Such increased current conduction causes the DC bias
voltage at a node A in the cathode signal path to decrease
accordingly until the correct bias condition is reached as
sensed by amplifier 35. Thus the closed loop control
20 action of the AKB feedback path including capacitor 20,
resistors 16 and 18, capacitor 32, amplifiers 33 and 35,
transistor 37 and resistors 38 and 39 stabilizes the peak
amplitude of signal P3 at a level of VR1-VR2,
corresponding to the correct black level kinescope bias
25 condition. In this example a correct bias condition
corresponds to current pulse P1 with a peak amplitude of
approximately 1 microampere, voltage pulse P2 with a peak
amplitude of approximately 1 millivolt, and voltage pulse
P3 with a peak amplitude of approximately +0.5 volts. By
30 feedback action network 30 will maintain such amplitude
levels by modifying the voltage at node A to compensate
for a sensed incorrect bias condition. Negligible loading
by DC restoration network 30 at video signal node A can be
achieved by choosing resistors 38 and 39 with low
35 parasitic capacitance, such as metal film resistors.

Normal blacker-than-black blanking to suppress
the kinescope beam spot during periodic horizontal and
vertical image retrace intervals is accomplished by means

1 of a negative going -150 volt pulse applied to kinescope
grid 24, rather than by blanking the video signal prior to
the kinescope driver amplifier. This method of
blacker-than-black retrace blanking eliminates the need
5 for the kinescope driver to accommodate the operating
point shifts otherwise associated with blacker-than-black
retrace blanking.

The manner in which black current representative
signal P2 is sensed via relatively low value series
10 sampling resistor 18 in the collector output circuit of
driver transistor 15 results in significantly reduced
capacitive loading of the kinescope driver stage. This
aspect of the disclosed AKB system is particularly
advantageous in a wideband system such as a video monitor,
15 and is described in greater detail in our concurrently
filed "European" patent application No. 85305685.1 (0174738).
Briefly, in order for a capacitive load to be
detrimental to the
frequency response of the kinescope driver, it must be
20 effective at the output of the driver (e.g., at the
collector output of transistor 15), or anywhere along the
signal path between the driver output and the kinescope
input. The input capacitance of AKB network 30 has
substantially no effect upon the high frequency response
25 of the driver stage because of the isolation produced by
relatively large load resistor 16 compared to smaller
sensing resistor 18, which desirably presents a much lower
impedance to the input capacitance of AKB network 30.

FIGURE 3 shows an alternative form of a portion of
30 the AKB system of FIGURE 1, wherein corresponding elements
are identified by the same reference number, and the leads
identified by dashed lines connect to the same places as
corresponding leads in FIGURE 1. The arrangement of
FIGURE 3 differs from that of FIGURE 1 with respect to the
35 manner in which clamping is accomplished, and with respect
to the manner in which signal P2 is amplified to produce
signal P3.

1 In FIGURE 3, both black current representative
signals P2 and P3 are clamped by means of a keyed
feedback clamping circuit including keyed amplifier 34
together with a video signal input capacitor 22 which AC
5 couples video signals to the base input of driver
transistor 15. The signal gain imparted to signal P2 to
produce signal P3 is provided by means of a circuit
including a PNP amplifier transistor with collector output
resistors 42 and 43 and an emitter resistor 44. The
10 desired signal gain of approximately 500 is determined by
the ratio of the value of resistor 43 to that of resistor
44. Resistor 42 serves to reduce the power dissipation in
transistor 31 by reducing its collector-to-emitter
voltage, thereby permitting use of a small, inexpensive
15 plastic type transistor for transistor 31.

 In both of the FIGURE 1 and FIGURE 3
arrangements, manual pre-adjustment of picture gray scale
balance can be achieved by varying reference voltage VR2
while maintaining reference voltage VR1 constant. This
20 would permit black level pre-adjustment over a small
range, such as may be required in certain applications
such as precision video monitors. Also, to increase the
high frequency response of driver 12, the values of the
collector and emitter resistances of transistor 15 can be
25 reduced, and a cascode amplifier arrangement could be
substituted for transistor 15.

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CLAIMS:

1. A video processing system having a driver amplifier stage, a kinescope and automatic kinescope bias apparatus, in which the video signals from the driver amplifier stage output are AC coupled to the kinescope cathode and the kinescope displays video information in accordance with the signals provided to its cathode, and in which the automatic kinescope bias apparatus automatically maintains the cathode bias of the kinescope in a desired condition and includes means which senses during an image blanking interval the magnitude of the black current conducted by the cathode by applying a cathode-current-enhancing pulse to the kinescope grid while a black level signal is coupled to the cathode, and means which responds to the sensed black current and produces a biasing signal related to the magnitude of the sensed black current, which biasing signal is applied to the kinescope cathode.

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2. A system according to Claim 1 wherein the driver amplifier stage output is coupled to the kinescope cathode by an AC coupled current path which comprises a coupling capacitor with an input coupled to said output circuit of said driver stage, and an output coupled to said kinescope cathode;

and the black level current is sensed at a point prior to said capacitor input; and said bias control signal is applied to a point after said capacitor output.

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3. A system according to Claim 1 or Claim 2 wherein the black current sensing means senses it at the output circuit of the driver stage.

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4. A system according to any of Claims 1 to 3, wherein the responsive means comprises a DC restoration means responsive to a signal derived from



the said sensed black current for biassing the kinescope cathode to maintain the desired bias condition.

5 5. A system according to any preceding claim, wherein the output circuit of said driver amplifier stage includes a load resistance and a sensing resistance series coupled between a signal output of said amplifier stage at an operating
10 potential supply point, said load resistance being connected nearer to said signal output and said sensing resistance being connected nearer to said operating potential supply point;

 and the responsive means is coupled to a
15 junction between said load and sensing resistances for sensing the magnitude of said representative signal.

 6. A system according to Claim 5, wherein the value of said load resistance is significantly
20 greater than the value of said sensing resistance.
