

DUPLICATE

SCAN LOSS DETECTOR FOR CATHODE RAY TUBE

This invention relates to video display apparatus and in particular to a cathode ray tube (CRT) protection circuits operating to detect and respond to deflection loss which otherwise may cause burning of the CRT screen phosphors.

Projection video display apparatus, such as television receivers, normally include three monochrome cathode ray tubes (CRTs) which individually produce red, green and blue images. The images are enlarged and overlaid as they are projected onto a screen. In order to form a final enlarged image of sufficient brightness to be acceptable under normal room lighting conditions, it is desirable to operate the individual cathode ray tubes at high brightness levels, i.e., at high electron beam current density.

The requirement of high beam current density results in a danger of damage to the phosphors on the CRT screens. Loss or reduction of horizontal or vertical deflection or scan in any or all of the cathode ray tube electron beams will cause an undesirable concentration of electron beam energy over a small region of the phosphors on one or more of the CRT screens. An undue concentration of energy may cause permanent damage to the CRT screen if the scan loss or reduction condition persists even for a short time. The problem is acute when horizontal or vertical scan loss occurs, and the scanning is reduced to a spot or line (i.e., no vertical and/or horizontal deflection), which produces a permanent variation in the light output of the affected phosphors of the CRT.

Deflection is driven by scanning rate currents in the electromagnetic deflection yokes which encompass the electron beam path. Various conditions can cause a loss of deflection, such as a component defect in the driving circuitry for the yokes, or an open circuit in the connections between the drivers and the respective yokes. Whereas three vertical deflection coils for the three CRTs may be connected serially, a plurality of connectors may be involved in coupling the vertical deflection current to the coils. Should any of these connectors be improperly engaged or their conductors shorted, for example during assembly or servicing, all three CRTs might be damaged.

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The CRTs are one of the more expensive elements of a projection television apparatus, and replacing a CRT is a substantial repair job. To protect the CRT screens from damage, it is important to provide some form of protection that can sense and promptly respond to a loss or reduction of electron beam deflection in an appropriate manner, for example by quickly blanking the concentrated electron beam or beams before the screen is damaged.

U.S. Patent No. 4,642,532 - Hoover discloses a projection television deflection loss protection circuit wherein signals representative of vertical and horizontal deflection currents are sensed. In the event of a loss of either of the horizontal or vertical deflection current, a signal is generated and used to trigger blanking of the display by disabling the kinescope (kine) driver.

U. S. Patent Application Serial No. 515,513, filed April 30, 1990 - George, entitled A PROTECTION CIRCUITS FOR A CATHODE RAY TUBE, (GB-A-2243752) discloses a scan loss protection apparatus wherein the voltage across the vertical trace capacitor (or S-shaping capacitor) provides an input to a comparator for detecting a loss of vertical deflection current. The trace capacitor is coupled in series with the vertical deflection coil. The current in the deflection coils is substantially a sawtooth. The voltage across the trace capacitor is a parabola at the vertical scanning rate. This parabola is AC coupled to a rectifier and the output of the rectifier charges a capacitor and defines an input to a voltage comparator. When vertical deflection current is lost, the capacitor discharges through a parallel resistance, defining an R-C time constant, and the signal input to the comparator falls below the reference level to trigger blanking.

The comparator signal input has a component at the vertical scanning frequency, as a result of the capacitor being slightly discharged and then charged in each vertical deflection cycle, and also a DC offset or average value. It may be desirable to set the reference level of the comparator, which is a DC level, far enough below the normal minimum level of the signal input to the comparator to avoid false triggering of the scan loss circuit. Specifically, the threshold should be, preferably, lower than the



normal minimum level by an amount, defining a guard band or noise margin. The guard band should be, preferably, sufficient to prevent normal variations such as noise on the signal input to the comparator, typical variations in the peak amplitude of the, 5 deflection drive signal from nominal and typical decrease in the capacitor voltage during a portion of the deflection cycle from causing triggering of the scan loss circuit. Upon loss of scan the capacitor discharges from its maximum voltage, occurring at the beginning of each cycle, through the normal operational span of 10 the discharging capacitor, and further through the guard band to reach the threshold of the comparator. A reaction time of the scan loss detector is defined from a time the deflection current is lost to the time CRT blanking occurs. The reaction time is determined by the R-C time constant, the signal voltage level and the 15 difference between the signal voltage level and the threshold.

In accordance with an aspect of the invention, to reduce the reaction time of a scan loss detector of the type discussed, an active amplifier is interposed between the source of a deflection signal, and the accumulating capacitor associated with 20 the comparator. The deflection signal, such as the voltage across the trace or S-shaping capacitor, is amplified in the amplifier that causes an increase in the voltage level developed across the capacitor during part of the period of each scan. The capacitor is discharged during the other part of each period through a parallel 25 resistor.

So long as vertical scanning continues, the capacitor voltage increases and decreases, alternately, in the corresponding parts of each vertical deflection cycle, but remains above a threshold level as detected by a comparator. Upon scan loss, the 30 capacitor discharges and the capacitor voltage ramps through the guard band below the threshold and the comparator triggers blanking of the kinescope driver.

The active amplifier, which advantageously is a current pulse generator is coupled between, for example, a 35 positive supply voltage and the capacitor and is responsive to negative peaks in a parabola derived from the trace capacitor. The amplifier produces a voltage in the capacitor that is higher than is possible by merely rectifying the deflection signal. The



higher capacitor voltage enables using a shorter time constant, resulting in a quicker capacitor discharge through a guard band, between the normal operational minimum capacitor voltage in each deflection cycle and the threshold. Advantageously, the peak capacitor voltage level does not significantly vary with the amplitude of the deflection signal, making the response time less dependent on the amplitude of the deflection signal.

A video display apparatus, embodying an aspect of the invention includes a cathode ray tube having an evacuated glass envelope. A display screen is disposed at one end of the envelope and an electron gun assembly is disposed at a second end of the envelope. The electron gun assembly produces an electron beam that forms a raster at electron beam landing locations on the screen. A deflection current is generated in a deflection winding that is disposed on the cathode ray tube for producing a deflection field in a beam path of the electron beam. A deflection signal is generated at an amplitude that is related to an amplitude of the deflection current. A comparator is responsive to a second signal for generating an output signal that is coupled to an electrode of the cathode ray tube to provide beam current blanking when a scan loss condition occurs. An active amplifier has an input responsive to the deflection signal for generating the second signal by amplifying the signal that is developed at the input of the amplifier.

FIGURE 1 illustrates a block diagram, embodying an aspect of the invention, as applied to a vertical scan loss detection;

FIGURE 2 is a circuit diagram showing a vertical scan loss detector, embodying another aspect of the invention;

FIGURE 3 is a block diagram showing application of the scan loss detector of FIGURE 1 or 2 to disable operation of a video display (kine) driver upon detection of vertical scan loss;

FIGURE 4 is a timing diagram showing operation of the invention according to FIGURE 3; and

FIGURE 5 is a schematic diagram showing coupling of the scan loss detection circuit to a kinescope driver.

Referring to FIGURES 1 and 3, a projection type video display apparatus, such as a television receiver, incorporates three monochrome CRTs or kinescopes 10, 11 and 12. Kinescope 10



produces red images; kinescope 11 produces green images; and kinescope 12 produces blue images. The three images are combined by an optical system (not shown) on a viewing screen, where they are viewed by the user as a composite color image.

- 5 Vertical deflection windings 14, 15 and 16 (FIG.1) are coupled in series between an output terminal 13a of a vertical deflection driving circuit 13 and a terminal 13b. A DC blocking capacitor C_v and a current sampling resistor R_s are coupled in series with the deflection windings 14, 15, 16, between terminal 13a and ground.
- 10 Circuit 13 produces a sawtooth vertical deflection current that flows into capacitor C_v to produce a vertical rate signal V_1 at terminal 13b. During normal operation the vertical rate signal V_1 includes a parabolic voltage component. Should a vertical scan loss occur, for example when any one of the windings 14, 15, 16
- 15 becomes an open circuit or when continuity is lost across terminals 13a, 13b or one of the intermediate connections, the parabolic signal V_1 does not develop.

- An output stage, not shown, drives horizontal scanning at the line rate, via horizontal deflection windings 20, 21, 22. The
- 20 horizontal output stage may include a flyback or high voltage transformer, not shown, with secondary windings providing power for the various load circuits, including an approximately +225 VDC supply voltage which is DC coupled for driving the cathodes of CRTs 10, 11 and 12.

- 25 The vertical parabola signal V_1 , that is at about 2.5 volts peak-to-peak, is slightly integrated by series resistor R_5 and parallel capacitor C_3 , and AC coupled via capacitor C_4 to an amplifier, embodying an inventive feature, including a PNP transistor Q_1 . The signal is coupled to the base of transistor Q_1
- 30 through series resistor R_6 , and the base of transistor Q_1 is biased relative to the positive DC supply voltage $+V$, for example +15 VDC. A diode D_2 clamps the parabola to positive supply voltage $+V$, and while the parabola signal is positive transistor Q_1 does not conduct. The emitter of PNP transistor Q_1 is coupled to the
- 35 positive supply V_+ . During the negative tips of the parabola, i.e., during narrow pulse intervals at the edges of the scan in the vicinity of vertical retrace, transistor Q_1 conducts from the positive supply, to charge capacitor C_5 .



The current through transistor Q1 and the voltage across capacitor C5 are shown in FIGURE 4 as I and V₂, respectively. Similar symbols and numerals in FIGURES 1 and 4 indicate similar items or functions.

5 During the intervals current pulses flow through transistor Q1 of FIGURE 1, the peak of a voltage V₂ of FIGURE 4 across capacitor C5 rises nearly to the level of the positive supply voltage V₊. Following a given current pulse, voltage V₂ across capacitor C5 of FIGURE 1 is drained away through parallel resistor
10 R8. Voltage V₂ across capacitor C5 is coupled to one input of a voltage comparator including operational an amplifier U2. The other input to the comparator is coupled to a reference voltage V_{REF} defining the threshold of the comparator. In the example according to FIGURE 1, the reference voltage is defined by a
15 reverse biased zener diode D3, coupled to the positive supply through a resistor R9 and to a parallel capacitor C6. Where the supply voltage is +15 volts the reference is appropriately set at about 10.6 volts.

So long as normal vertical scanning continues, a new
20 current pulse from transistor Q1 arrives to recharge capacitor C5 before it discharges to the threshold of comparator U2. If, due to a fault, the AC input from the trace capacitor C_v is lost, and no new pulse arrives, the output of the comparator changes state as voltage V₂ on capacitor C5 drops below the reference voltage. A
25 vertical scan loss signal VERTICAL SCAN LOSS is then generated through a driver transistor Q2. The base of transistor Q2 is coupled to the comparator output through series resistor R11 and biasing resistor R10. When the output of the comparator goes low (i.e., when the reference voltage coupled to the inverting input of
30 operational amplifier U2 is higher than the voltage across capacitor C5 coupled to the non-inverting input), PNP transistor Q2 conducts. Transistor Q2 is arranged as a follower amplifier, the output at the emitter of transistor Q2 being coupled to a positive supply voltage through a resistor R12 and a capacitor C7, and the
35 collector being coupled to ground through a resistor R13. During normal operation, the output at the emitter of transistor Q2 is at about +12 volts, and upon scan loss the output goes to zero.

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: Scan loss signal VERTICAL SCAN LOSS from transistor Q2 is coupled to an arrangement for blanking the display by disabling generation of the electron beam current, as shown in FIGURE 3 or 5. Similar symbols and numerals in FIGURES 1, and 3-5 indicate similar items or functions.

Referring to FIGURE 3, the beam current is normally generated by kinescope driver 23, in response to the output of video processor/amplifier 19, which decodes and amplifies the video signal received from an antenna, or some other source. The output of the video processor 19, for example, controllably causes a cathode electrode current of the CRT to flow via kinescope driver 23 and via a transistor Q4, whose emitter is coupled to ground through resistor R17. Separate kinescope drivers 23 and transistors Q4 are provided for the respective CRTs 10, 11, 12, only one being shown in the drawing.

Each of the three kinescope drivers is coupled to its respective transistor, Q4, through a corresponding switching transistor, Q3, in a cascode amplifier configuration of transistors Q4 and Q3. Transistor Q3 for each CRT has a base coupled to scan loss signal VERTICAL SCAN LOSS through one of resistors R16, R15 or R14. Provided transistor Q3 is conducting (i.e., in the absence of a low level indicating scan loss on the base of Q3), video signals VR, VG and VB produced by video processing stage 19 and coupled to the bases of each respective transistor Q4 are coupled to the appropriate kinescope driver 23 and electron beam current is provided to the CRT cathode.

FIGURE 5 illustrates in more detail a conventional output kinescope driver stage 23 to be driven from the video processor/amplifier 19 through transistors Q4 and Q3. Similar symbols and numerals in FIGURES 1 and 3-5 indicate similar items or functions. Stage 23 of FIGURE 5 includes a series arrangement formed by an inductor L1, a diode D4, an inductor L2, a resistor R19 and resistor R18. This series arrangement forms a collector load at the collector of transistor Q3 (and, through transistor Q3, at the collector of transistor Q4). A high level amplified video signal is developed at the collector of transistor Q3, provided it is conducting. The output of the driver stage includes opposite conductivity type emitter follower



transistors Q5 and Q6, forming a Class B amplifier with base inputs coupled to the collector of transistor Q3 across diode D4. The emitter output of transistor Q5 is coupled to the emitter output of transistor Q6. The high level amplified video signal is coupled

5 from the emitter output of PNP follower transistor Q6 or of NPN follower transistor Q5, which corresponds to an output terminal of the driver stage, to a cathode electrode of the image reproducing kinescope or CRT 10, via a kinescope arc current limiting resistor R24 and peaking circuitry including resistor R23 and inductor L3.

10 A collector resistor R22 coupled to transistor Q6 acts as a kinescope arc current limiting resistor.

Kine supply voltage is provided at approximately +225 volts through resistors R17 and R20 to the collector of transistor Q5, and is coupled to the series arrangement including resistors

15 R18, R19, also through R17. A filter capacitor C8 is coupled to the junction of resistors R17 and R18.

When a user turns off the power to the television receiver, for example by disconnecting the mains supply voltage, deflection loss occurs and the voltage of signal VERTICAL SCAN

20 LOSS goes to near zero. Accordingly, transistor Q3 becomes nonconductive. So long as the kine supply voltage remains positive (e.g., from stored charge in the receiver's filter capacitor), a positive cathode voltage is maintained in the CRT. The control grid voltage of the CRT can be maintained at a less positive level,

25 and the voltage difference between the cathode and the control grid causes a beam current cutoff condition wherein the beam current is substantially zero. In this manner CRT 10 is protected from phosphor damage even if the ultor voltage is sufficiently large to produce a beam current.

30 Whether a scan loss occurs when power to the television is turned on, or when the user turns off the power to the television such that the kine supply voltage falls off but the ultor voltage remains high, transistors Q3 and Q6 remain nonconductive to disable beam current emission. A conventional

35 grid biasing and cutoff circuit, not shown, may be provided as a redundant means operable in addition to the scan loss circuits.

As shown schematically by an OR gate U3 in FIGURE 3, a scan loss signal can be generated in the event of deflection



failure in either, or both of the vertical and horizontal scanning circuits. Although only the generation of the vertical scan loss signal is discussed in detail, a horizontal scan loss signal HOR. SCAN LOSS can be generated in a well known manner when,
5 horizontal scan loss occurs.

In accordance with an inventive feature, the peak voltage level of voltage V_2 of FIGURE 4 developed across integrating capacitor C5 of FIGURE 1, which discharges during a substantial portion of vertical trace, is substantially greater than
10 the amplitude of input signal V_1 . According to the embodiment of FIGURE 1, the peak level of voltage V_2 in capacitor C5 is approximately equal to the power supply voltage V_+ , and is related to the input parabola in that the capacitor is charged to the supply voltage, during the minimum peaks of the parabola, in
15 the vicinity of vertical retrace. By providing this large voltage across capacitor C5, a shorter time constant can be utilized than without voltage amplification that is obtained by transistor Q1. This can be appreciated with respect to FIGURE 4.

Voltage V_2 of FIGURE 4 across capacitor C5 decays
20 from its peak level of about +15 volts to a normal operational minimum level 24 of +12 volts during every normal operation vertical scan interval, at a rate defined by the values of capacitor C5 and the parallel resistance defined by resistor R8 and the input impedance of the comparator U2 (which is normally large for an
25 operational amplifier comparator as shown). In the illustrated example, the time constant τ is about 65 msec. ($240K \times 0.27 \mu F = 64.8 \text{ msec}$). A threshold level 25 of comparator U2 of 10.6 volts is lower than the normal operational minimum level 24 of voltage signal V_2 , by an amount defining a guard band. The guard band
30 allows a certain normal variation in the normal operational minimum level 24, without triggering the output of the comparator U2. In connection with a supply voltage of 15 volts, the minimum operational level 24 is, for example, about 12 volts, and the threshold level is set at about 10.6 volts to provide a
35 guard band of 1.4 volts.

When a scan loss occurs, voltage V_2 decays through its usual span of discharge of capacitor C5, and also through the guard band. The decay through the guard band is a continuation



of the usual operational decay, and approximately at the same characteristic rate. If the difference between the peak of voltage V_2 and voltage V_{REF} were significantly smaller, the selected slope of the decay would have had to be also significantly lower, due to discharge from a lower voltage difference during approximately the same interval. Therefore, after scan loss occurs, the decay of voltage V_2 through the guard band to the threshold level V_{REF} would be longer. Accordingly, the higher voltage difference produced by amplifying signal V_1 in the amplifier has the beneficial result of allowing using a shorter time constant, a steeper slope, and, therefore, a quicker detection of a scan loss.

FIGURE 2 illustrates a second embodiment of the invention. Similar symbols and numerals in FIGURES 1-5 indicate similar items or functions. Referring to FIGURE 2, to prevent damage to the phosphors in the event of a loss of scanning, parabolic voltage V_1' of the AC deflection signal is AC coupled to an active amplifier U1. The amplifier U1 has a positive gain or amplification. The higher gain signal at the output of amplifier U1 is rectified by a peak detector diode D1, and applied to an integrating capacitor C5'. The voltage level on capacitor C5' is compared to a threshold voltage V_{REF}' . Capacitor C5' is coupled to parallel resistance R8', which discharges the capacitor over time. So long as the AC signal representing deflection remains present, the capacitor voltage remains above the threshold of comparator U2. When the AC signal is lost, the capacitor discharges through the parallel resistance. The capacitor and the parallel resistance have a time constant short enough such that, when scan loss occurs, the voltage level across the capacitor falls below the threshold before the phosphors on the screens of the CRTs 10, 11, 12, can be burned. The time constant is long enough such that the capacitor does not discharge below the threshold during normal operation. The output of comparator U2 enables or disables the supply of current to the CRT cathode via the kinescope driver, as explained before.





CLAIMS:

1. A video display apparatus, comprising:
a cathode ray tube including an evacuated glass
envelope, a display screen disposed at one end of said envelope
and an electron gun assembly disposed at a second end of said
5 envelope, said electron gun assembly producing an electron beam
that forms a raster at electron beam landing locations on said
screen;

means for generating a deflection current in a
deflection winding that is disposed on said cathode ray tube for
10 producing a deflection field in a beam path of said electron beam;

means coupled to said deflection current generating
means for generating a deflection signal at an amplitude that is
related to an amplitude of said deflection current;

a capacitor;

15 means responsive to said deflection signal for
generating periodic current pulses in said capacitor to develop a
voltage in said capacitor such that, during normal operation, a
peak level of said voltage in said capacitor is at a constant level
independently of said amplitude of said deflection current;

20 means coupled to said capacitor for discharging said
capacitor between said pulses; and

a comparator responsive to said capacitor voltage for
generating an output signal that is coupled to an electrode of said
cathode ray tube to provide beam current blanking when a scan
25 loss occurs.

2. A video display apparatus, comprising:

a cathode ray tube having a phosphor screen, an
electron gun assembly for emitting an electron beam directed
against said screen, and a deflection winding for producing one of
30 horizontal and vertical scanning of the electron beam on the
screen;

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means coupled to said deflection winding for producing a deflection signal at a frequency that is related to a scanning rate;

means responsive to said deflection signal for
5 generating DC pulses of substantially constant peak amplitude that are independent of an amplitude of said deflection signal, said DC pulses occurring at said frequency that is related to said scanning rate;

a capacitor coupled to an output of said DC
10 pulses generating means;

means coupled to said capacitor for discharging said capacitor between said pulses; and

a comparator having a signal input coupled to said capacitor and the comparator producing an output signal
15 when a level at said signal input crosses a threshold level of said comparator, said output signal of said comparator being coupled to an electrode of said cathode ray tube for triggering blanking of the beam.

3. An apparatus according to Claim 2, wherein said
20 deflection signal is generated in a trace capacitor having a parabola waveform with voltage having peaks occurring remote in time from a center of a scan, and wherein said pulses generating means includes a transistor operable to provide narrow DC current pulses to the capacitor during said peaks, whereby the transistor
25 functions as an amplifier and as a rectifier.

4. The television apparatus according to Claim 2 further comprising, a second cathode ray tube having a second deflection winding coupled to said trace capacitor, and wherein the comparator is operable to provide beam current blanking of
30 all of said cathode ray tubes.

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5. A television apparatus comprising:

a cathode ray tube having a phosphor screen, means for emitting an electron beam against the screen, and deflection yokes for producing deflection of the electron beam on the screen;

5 a trace capacitor coupled to at least one of the deflection yokes, the trace capacitor producing a voltage signal having an AC component at a scanning rate of the beam;

10 a pulse generator coupled to the voltage signal of the trace capacitor, the pulse generator providing DC pulses of substantially constant amplitude that is independent of an amplitude of said voltage signal, narrower than a period of the scanning rate, as a function of detection of the AC component in the voltage signal of the trace capacitor;

15 a capacitor coupled to an output of the pulse generator, and a resistance in parallel with the capacitor for discharging the capacitor between said pulses;

20 a comparator having a signal input coupled to the capacitor and a reference input, the signal input being coupled to the capacitor and the comparator producing an output signal when a level of the signal input crosses that of the reference input, the output signal of the comparator being coupled to the means for emitting the electron beam and triggering blanking of the beam.

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