

Description

## A CIRCUIT FOR ADJUSTING THE CORING THRESHOLD OF A SIGNAL

Technical Field

The present invention relates to coring circuits that allow the transmission of a signal only if its amplitude exceeds a predetermined coring threshold, and more particularly to a  
5 circuit for adjusting the coring threshold as a function of the signal amplitude.

Background of the Invention

A coring circuit is used in a peaking circuit that accentuates outlines of an object in a television picture. The  
10 coring circuit is used to avoid the detrimental peaking effects caused by the noise present in the low levels of the signal to be processed.

Figure 1a represents a transfer characteristic of a conventional coring circuit. As long as the input signal  $V_{in}$  of the circuit has an absolute value lower than a coring value  $V_{c1}$ ,  
15 the coring circuit provides a zero output  $V_{out}$ . As soon as the value  $V_{c1}$  is exceeded, the output  $V_{out}$  varies as a function of signal  $V_{in}$ .

The characteristic of Figure 1a corresponds to the characteristic obtained when the coring value  $V_c$  is constant as  
20 shown in Figure 1b. In this case, Figure 1a shows that the output  $V_{out}$  corresponds to the portion of signal  $V_{in}$  which exceeds value  $V_{c1}$ .

Some applications require that the transfer  
25 characteristic be similar to that represented in Figure 2a. When signal  $V_{in}$  exceeds a breakpoint value  $V_b$ , the coring value  $V_c$  is decreased down to a zero value, so that the output  $V_{out}$  reaches an exact copy of signal  $V_{in}$  when the amplitude of the signal  $V_{in}$  increases above an intercept value  $V_{int}$ .

For this purpose, the above-mentioned standards recommend a variable characteristic of the coring value  $V_c$  that is a function of the input signal  $V_{in}$ .

Figure 2a illustrates this characteristic. Up to a  
5 breakpoint value  $V_b$  of signal  $V_{in}$ , the coring value  $V_c$  is constant and equal to a limit value  $V_{cl}$ . Above value  $V_b$ , the coring value  $V_c$  linearly decreases and reaches zero at an intercept value  $V_{int}$  of signal  $V_{in}$ .

The limit value  $V_{cl}$  should be selectable between 0 and  
10 7% of the maximum amplitude of signal  $V_{in}$ , the intercept value  $V_{int}$  should be selectable between 45 and 85% of the maximum value of signal  $V_{in}$ , and the breakpoint value  $V_b$  should be selectable between 0 and value  $V_{int}$ . Thus, the characteristic curve of Figure 2b may have several forms depending upon the values  $V_{cl}$ ,  
15  $V_b$ , and  $V_{int}$ . Figure 2b represents two exemplary forms, one drawn in solid lines and the other in dash lines.

#### Summary of the Invention

An object of the present invention is to provide a particularly simple circuit for achieving the characteristic of  
20 Figure 2b.

To achieve this object, the present invention provides a circuit including an asymmetrical differential stage having a low gain branch and a high gain branch. The low gain branch is controlled by the input voltage and supplies a first load. The  
25 high gain branch supplies a second load of same nature as the first load and is controlled by a voltage which corresponds to the beginning of the decreasing portion. A first current source establishes the current of the asymmetrical differential stage. This current corresponds to the end of the decreasing portion. A  
30 symmetrical differential stage has a first branch controlled by the low gain branch and provides the output signal of the circuit. A second branch of the symmetrical differential stage is controlled by the high gain branch. The current of the symmetrical differential stage is established at a value which  
35 corresponds to the maximum amplitude of the output signal.

According to an embodiment of the invention, the asymmetrical differential stage includes first and second transistors. The first transistor, associated with the high gain branch, is connected between the second load and the first current source. The second transistor, associated with the low gain branch, is connected to the first current source through a resistor and is connected to the first load.

According to another embodiment of the invention, the first and second loads are diodes and the symmetrical differential stage includes two transistors that are symmetrically connected to a second current source which establishes the current of the symmetrical differential stage.

#### Brief Description of Drawings

The foregoing and other objects, features, aspects and advantages of the invention will become apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

Figure 1a, shows a transfer characteristic of a coring circuit;

Figure 1b shows a characteristic of a constant coring value;

Figure 2a shows a transfer characteristic of a coring circuit recommended by present standards in the television field;

Figure 2b shows a characteristic of the variation of the coring value, recommended by present standards in the television field;

Figure 3 shows an embodiment of a circuit according to the invention for achieving the characteristic of Figure 2b;

Figure 4 shows a block diagram of a television set according to the present invention; and

Figure 5 shows a detail of the block diagram of Figure 4.

#### Detailed Description of the Invention

Figure 3 shows a circuit providing a current  $I_c$  which can control any conventional coring circuit, either directly, or

after a current to voltage conversion, for fixing the coring value  $V_c$  (Figures 2a and 2b). The conventional coring circuit, not involved in the present invention, is not described.

5 The input signal of the coring circuit, voltage  $V_{in}$ , is applied on the base of an NPN transistor Q1 which forms with a transistor Q2 an asymmetrical differential stage. The emitter of transistor Q2 is connected to the emitter of transistor Q1 through a resistor 10 and to a low supply voltage GND through a  
10 current source 12 providing a current  $I_{int}$  which corresponds to the intercept value  $V_{int}$  of the characteristic of Figures 2a and 2b.

The collectors of transistors Q1 and Q2 are connected respectively to the bases of two NPN transistors Q3 and Q4, that form a symmetrical differential stage. The emitters of  
15 transistors Q3 and Q4 are connected to voltage GND through a current source 14 providing a current  $I_{C1}$  which corresponds to the limit value  $V_{C1}$  of the characteristic of Figure 2b. The collector of transistor Q3 provides the current  $I_c$  which corresponds to the coring value  $V_c$ . The current  $I_c$  may be converted  
20 into a voltage or mirrored by a current mirror (not shown) to be restored with suitable polarity and gain.

Values  $I_{int}$ ,  $V_b$  and  $I_{C1}$  are provided by independent sources which allow a free control of each particular point of the characteristic of Figure 2b.

25 The bases of transistors Q3 and Q4 are connected to the collector of transistor Q4 through two biased diodes D1 and D2, respectively. The collector of transistor Q4 is further connected to a high supply voltage  $V_{cc}$  through a biased diode D3. In one embodiment, diodes D1, D2 and D3 are formed by, for example, NPN  
30 transistors, each of which has its base connected to its own collector. In another other embodiment, diodes D1, D2, and D3 are stand-alone, discrete component diodes.

When voltage  $V_{in}$  is lower than voltage  $V_b$ , no current flows in resistor 10. All current  $I_{int}$  of source 12 flows in  
35 transistor Q2 and diode D2. Diode D1 is biased only by the base

current of transistor Q3. Since the current in diode D1 is substantially lower than the current in diode D2, the base voltage of transistor Q3 is significantly higher than the base voltage of transistor Q4. As a result, transistor Q3 derives all  
 5 current  $I_{C1}$  of source 14.

The circuit of Figure. 3 is maintained in this state independently of the voltage  $V_{in}$  when  $V_{in}$  is lower than voltage  $V_b$ . This provides the horizontal portion of the characteristic of Figure 2b which corresponds to a constant current  $I_c$ , equal to  
 10 the limit value  $I_{C1}$ .

When voltage  $V_{in}$  exceeds voltage  $V_b$ , a current  $i$  equal to  $(V_{in}-V_b)/R$  is established in resistor 10, where  $R$  is the value of resistor 10. Then, current  $i$  flows through diode D1 and a current  $I_{int}-i$  flows through diode D2. The current in diode D1  
 15 increases whereas the current in diode D2 decreases. As a consequence, the base voltage of transistor Q3 decreases whereas the base voltage of transistor Q4 increases. An increasing portion of current  $I_{C1}$  of source 14 then flows through transistor Q4, which decreases current  $I_c$ .

When voltage  $V_{in}$  is high enough for all current  $I_{int}$  of source 12 to flow through transistor Q1, diode D1 conducts current  $I_{int}$ , whereas diode D2 conducts only the bias current of transistor Q4. Transistor Q4 derives all current  $I_{C1}$  of source 14, and current  $I_c$  is zero, even though voltage  $V_{in}$  continues to  
 25 increase.

The connection of the differential stage Q3, Q4 and diodes D1 and D2 provides a linear transition between the moment when the collector current of transistor Q1 becomes zero for  $V_{in}=V_b$ , and the moment when the collector current of transistor Q2 becomes zero for  $V_{in}=V_b+RI_{int}$ . Thus, the circuit of Figure 3 provides the linearly decreasing, then the zero, portions of the  
 30 characteristic of Figure 2b.

In an alternative embodiment, diodes D1 and D2 could be replaced by resistors. However, it is then more difficult to  
 35 determine the transitions between the moments when only one of

the transistors Q3 and Q4 is conductive and when both transistors Q3 and Q4 are conductive, i.e., the values  $V_D$  and  $V_{int}$  which determine the beginning and the end of the decreasing portion of the characteristic of Figure 2b.

Diode D3 is optional. It is used to increase the power supply rejection ratio and to decrease the base voltages of transistors Q3 and Q4, so that the collector of transistor Q3 can, if necessary, control the input of a current mirror connected to voltage  $V_{CC}$ , without transistor Q3 saturating.

As is apparent to those skilled in the art, various modifications can be made to the above disclosed preferred embodiments. For example, diodes D1 and D2 can be replaced by resistors or other resistance elements and the differential stage Q3, Q4 can be accordingly adapted to establish the decreasing portion of the characteristic. Further, transistors Q1-Q4 can be implemented using MOS, CMOS, or BICMOS technology.

As will be appreciated by those skilled in the art, a video unit such as a television set can include a circuit according to the present invention. Figure 4 shows a block diagram of a television set 20 that includes VHF/UHF tuners 22, intermediate frequency (IF) amplifiers 24, a video detector 26, and a video amplifier 28. Television set 20 also includes a sound IF amplifier 30, a frequency modulation (FM) detector 32, an audio amplifier 34, an audio output circuit 36, and a speaker 38. The above circuits are well known; they may be provided by known conventional circuits, many of which are acceptable. Figure 4 also shows a video output circuit 40 for receiving a signal VIDEO IN from the video amplifier 28 in the form of luminance (Y) and chrominance (U, V) signals, and for providing a signal VIDEO OUT to a display device 42, such as a cathode ray tube or a flat panel display.

Figure 5 shows that, according to the present invention, the video output circuit 40 includes a peaking circuit 44 and a coring threshold adjust circuit 46 which usually act on the luminance signal  $Y_{in}$  of the video signal. The peaking circuit 44

receives the luminance signal  $Y_{in}$  and accentuates outlines of objects displayed on the display device 42. The peaking circuit 44 includes a conventional coring circuit (not shown) for transmitting as a signal  $Y_{out}$  the portions of signal  $Y_{in}$  with an amplitude greater than a coring threshold. According to the present invention, the video output circuit 40 also includes a coring threshold adjust circuit 46 for adjusting the coring threshold as a function of the amplitude of the signal  $Y_{in}$ . Figure 3 shows an example of the coring threshold adjust circuit 46.

The coring threshold adjust circuit 46 adjusts the coring threshold such that the coring threshold has a first coring threshold level when the amplitude of the signal  $Y_{in}$  is less than or equal to a first voltage level. The coring threshold has a second coring threshold level when the amplitude of the signal  $Y_{in}$  is greater than or equal to a second voltage level; the second voltage level is greater than the first voltage level. The coring threshold has a third coring threshold level between the first and second coring threshold levels when the amplitude of the signal  $Y_{in}$  is between the first and second voltage levels. Further, the third coring threshold level varies substantially linearly as the amplitude of the signal  $Y_{in}$  varies between the first and second voltage levels.

As will be appreciated, a first alternative embodiment of television set 20 can represent an audio/video monitor. This first alternative embodiment includes the video amplifier 28, the audio amplifier 34, the audio output circuit 36, the speaker 38, the video output circuit 40, and the display device 42. The video output circuit 40 includes a coring threshold adjust circuit 46 as described above. The VHF/UHF tuners 22, the IF amplifiers 24, the video detector 26, the sound IF amplifier 30, and the FM detector 32 are optional and are not necessary in the first alternative embodiment.

In a second alternative embodiment, television set 20 can represent a video monitor. This second alternative embodiment

includes the video amplifier 28, the video output circuit 40, and the display device 42. The video output circuit 40 includes a coring threshold adjust circuit 46 as described above. The audio amplifier 34, the audio output circuit 36, the speaker 38, and the optional components of the audio/video monitor described above are optional and are not necessary in the second alternative embodiment.

Even though the invention has been described with relation to a coring circuit, it applies to any case in which it is required to provide a signal having a constant maximum amplitude, followed by a portion decreasing down to a zero constant value when an input signal increases from zero. Further, because of the ease of implementation as will be appreciated by those skilled in the art, a circuit according to the invention can easily be integrated on a semiconductor substrate.

Having thus described at least one illustrative embodiment of the invention, various alterations, modifications and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only and is not intended to be limiting. The invention is limited only as defined in the following claims and the equivalents thereto.

CLAIMS

1. A circuit for providing an output signal ( $I_c$ ) having a portion with a constant maximum amplitude followed by a decreasing portion decreasing down to a constant zero value when an input voltage ( $V_{in}$ ) increases from zero, the circuit comprising:

an asymmetrical differential stage (Q1, Q2) having a low gain branch (Q1) and a high gain branch (Q2), the low gain branch being controlled by the input voltage and supplying a first load (D1), the high gain branch supplying a second load (D2) and being controlled by a voltage ( $V_b$ ) corresponding to a beginning of the decreasing portion;

a first current source (12) which establishes a current of said asymmetrical differential stage, the current ( $I_1$ ) corresponding to an end of the decreasing portion;

a symmetrical differential stage (Q3, Q4) having a first branch (Q3) controlled by the low gain branch and providing the output signal, said symmetrical differential stage having a second branch (Q4) controlled by the high gain branch; and

means (14) for establishing a current of the symmetrical differential stage at a value ( $I_1$ ) corresponding to the maximum amplitude.

2. The circuit of claim 1, wherein said asymmetrical differential stage comprises:

first and second transistors, said first transistor (Q2) being associated with the high gain branch and being connected between the second load and said first current source (12), said second transistor (Q1) being associated with the low gain branch and being connected to said first current source through a resistor (10) and being connected to the first load.

3. The circuit of claim 1, wherein the first and second loads each comprise a diode (D1, D2) and wherein said symmetrical differential stage comprises third and fourth transistors (Q3,



Q4) symmetrically connected to a second current source (14) which establishes the current of the symmetrical differential stage.