

Description

The invention relates to an extended definition television system in which a wide aspect ratio picture and at least one horizontal border conveying enhancement signals together constitute a standard aspect ratio picture.

EP-A-0,168,104 discloses an adapted MAC television system in which a wide aspect ratio (5/3) picture is rendered possible by reducing the number of digital data bits in the horizontal blanking period. Additional data transmission capacity is created by sacrificing some video signal lines adjacent to the vertical blanking interval.

The article "6-MHz single-channel HDTV systems", by William F. Schreiber, presented at the HDTV Symposium in Ottawa, October 1987, discloses a backward-compatible single-channel system in which the different aspect ratio of a proposed HDTV system and of NTSC are accommodated by removing part of the height of the NTSC picture. If 25% of the NTSC picture height is usurped (60 lines each at top and bottom), a picture 360 lines high with an aspect ratio of 16:9 remains. If the top and bottom areas are used for enhancement signals, it would be possible to achieve near MUSE quality on a special receiver. The standard receiver would see bars of moving noise - the enhancement signals - in these areas. The annoyance level could be reduced somewhat by proper signal design. No further details are provided.

It is, *inter alia*, an object of the invention to provide a practically working extended definition television system in which a wide aspect ratio picture and at least one horizontal border conveying enhancement signals together constitute a standard aspect ratio picture. To this end, a first aspect of the invention provides a method of encoding an extended definition television signal as defined in claim 1. A second aspect of the invention provides a device for decoding an extended definition television signal as defined in claim 5. A third aspect of the invention providing a television display apparatus comprising such a decoding device, is defined in claim 9. Advantageous embodiments are defined in the subclaims.

In a preferred form of the present invention an extended definition television (EDTV) system provides progressively scanned EDTV signals that may be displayed on NTSC television receivers, and NTSC signals may be displayed on an EDTV receiver. Also, in the preferred embodiment progressively scanned EDTV signals are displayed on an EDTV receiver with increased vertical resolution over NTSC signals received on a NTSC receiver.

The source image of the EDTV system is a progressively scanned image with an aspect ratio of 4:3. There is a picture portion of the image which has an aspect ratio of 16:9 and a horizontal border portion of the image which fills out the image to the aspect ratio

of 4:3. The source image is progressively scanned with 480 lines (360 lines for the picture portion and 120 lines for the border portion) with a horizontal scan rate of 26 microseconds per line. The NTSC standard source signal is scanned with 240 lines and a horizontal scan rate of 52 microseconds per line. In order for the EDTV signal to be compatible with the NTSC system, the source image must be processed further.

Two signal components are formed and assembled for transmission within a single NTSC channel. The first signal component (I) is formed by selecting alternate lines from the source (called vertical down-sampling) and time expansion (called scan conversion) in the horizontal direction. The second signal component (Q) is composed of line differential information which is formed by finding the difference between a line and the average of the two adjacent lines. The Q component is then vertically-down-sampled and scan converted in a manner similar to the I component. The two component signals (I and Q) contain all of the information from the original source signal. Both components are compatible with the NTSC standard, but there is only enough room in the NTSC bandwidth to send one complete signal.

In order to transmit additional information within a single NTSC channel, a method of in-phase and quadrature modulation of the picture carrier is used. The I component is used to modulate the in-phase portion of the carrier in a manner identical to that presently used to modulate NTSC carriers. In addition, the carrier contains quadrature side bands. These side bands are only 1.25 MHz wide, where the in-phase portion is 4.2 MHz wide. Only a portion of the Q component may be modulated onto the quadrature side band.

The Q component is low pass filtered (LPF) to about 1.25 MHz and then is applied as the quadrature modulating signal of the picture carrier. The LPF Q signal is subtracted from Q to give a high pass filtered (HPF) Q signal. This HPF Q signal may be inserted into the border areas of the I signal. Since there are only 1/3rd as many lines per field in the border areas as there are in the active picture area, it will require three field periods to fully update a scene with HPF Q components. For non-moving portions of a picture this poses no problem. For moving portions of the picture, a motion detector is incorporated at the source of transmission that deletes the "moving" Q signal components from the border areas. The LPF Q signal is used to modulate the quadrature side band and is updated continually therefore, no motion detector is required for that component. In the preferred embodiment, the Q component picture is separated into a LPF luminance signal, a HPF luminance signal and a LPF color signal. The LPF luminance signal is used to quadrature modulate the picture portion of carrier. The remaining two signals are inserted into the borders. That is, the HPF luminance signal is used for in-

phase modulation and the LPF color signal is used for quadrature modulation of the carrier signal border portion. That portion of the Q component color signal having a frequency above the LPF is not transmitted.

At the EDTV receiver, full bandwidth Q signals may be recovered (for non-moving portions) by reassembling LPF and HPF Q signals. The full bandwidth Q signals are then used to recover the lines deleted from the original program source signal. Thus, a progressive scanned display may be achieved that has maximum vertical detail for non-moving pictures.

At a NTSC receiver, only the I components of the source signal can be received. NTSC receivers are designed to filter out the quadrature side bands and, therefore, the LPF Q signal is not detected. The HPF Q signals are still in the border areas of the I signal, however. These HPF Q signals may be "hidden" so that they are not distracting to the viewer. A masking signal such as a pattern in the border area may be used to hide the HPF Q signals so that they are not distracting for the viewer. Alternatively, the black level clamping point may be changed by inserting a pedestal at the horizontal blanking back porch, so that the HPF Q signal peaks are below black (super black).

The signal processing circuits of the EDTV receiver reassemble the various signal components detected by the in-phase and quadrature synchronous demodulators, develop missing line information that was deleted from the original source signal, perform scan conversion, and expand the picture portion of the image to a full 16:9 aspect ratio. Unlike NTSC receivers, an EDTV receiver has two video IF demodulators: one for the in-phase signal and one for the quadrature signal. The I and Q signals may then be obtained, and the original scan signal may be reassembled by appropriate circuitry.

In order to provide a progressively scanned display, the horizontal scan rate of the EDTV receiver is twice that of standard NTSC receivers. The vertical scan rate, however, is the same as standard NTSC. The scan rates of an EDTV display match those of the source signal, but the number of lines containing the picture in the source signal is only 3/4ths the number of active lines available; the source signal has 360 lines of picture with 120 lines of border and the display has 480 lines available for picture display. It is desirable to delete the border areas and expand the picture vertically for a correct display of the source picture on the 16:9 aspect ratio screen. The 360 lines of picture are up-sampled in a ratio of 4:3 in order to provide the required vertical expansion to 480 lines. This is accomplished by a vertical filter and field store circuit.

The EDTV receiver may also be used to display a standard NTSC signal. The scan rate of the NTSC standard signal is 53 microseconds; by the use of a horizontal time compression circuit, a scan rate of 19.5 microseconds may be achieved. This scan rate

will display a 4:3 aspect ratio picture with at least one vertical border area. A line averaging circuit may be used to up-sample the 240 line picture to a 480 line picture.

A simplification of the transmitter and receiver circuits may be achieved if a trade-off on performance and economic considerations is made. If one notes that the human eye cannot resolve fine color detail, it is not necessary to improve the vertical color resolution over the standard NTSC amount. Therefore, instead of transmitting the line differential color components, the receiver will use adjacent line averaged color components for the missing line. Also, some subjective experiments have shown that the bandwidth for the line differential signals can be significantly reduced. Thus, if one does not include in the transmittal signal the high pass filtered line differential signals, only the low pass line differential signals will be used. If the two above changes are made to the previous system no color or HPF line differential signals are sent in the border areas. This leaves the area free for new usage (such as digital audio). The picture processing circuitry then becomes much simplified.

The present invention may be best understood by reference to the following detailed description of preferred embodiments when considered in conjunction with the drawings in which:

FIGURE 1a shows the display of an EDTV signal of the present invention on a NTSC receiver;

FIGURE 2b shows the display of the EDTV signal on an EDTV receiver;

FIGURE 1c shows the display of a NTSC signal on an EDTV receiver;

FIGURE 2 shows the format of a progressively scanned source image for the EDTV signal;

FIGURE 3 shows the resulting NTSC compatible signal after the source image of FIGURE 2 is processed in accordance with the present invention;

FIGURE 4 is a block schematic diagram of the I and Q signal component generation circuit;

FIGURE 5 is a block schematic diagram of the premodulator components of an EDTV broadcast signal transmission system;

FIGURE 6 is a block schematic diagram of the RF, IF, and detector portions of an EDTV receiver; FIGURES 7a and 7b are a block schematic diagram of the signal processing circuits in an EDTV receiver;

FIGURE 8a is a block schematic diagram of the Field Store and Vertical Filter blocks shown in FIGURE 7;

FIGURE 8b is a chart depicting the operation of the filter blocks shown in FIGURE 7.

FIGURE 9 is a block schematic diagram of a simplified EDTV transmitter; and

FIGURE 10 is a block schematic diagram of a

simplified EDTV receiver.

Referring now to the drawings in which like reference characters designate like or corresponding parts throughout the several views, there is shown in FIGURE 1a the display of an EDTV signal of the present invention in a preferred form on a NTSC receiver. The NTSC display 12 has an aspect ratio of 4:3. There is also shown an EDTV signal which consists of a picture portion 14 and a border portion 16. The picture portion 14 has an aspect ratio of 16:9 and the border portion 16 fills the NTSC display 12 to a 4:3 aspect ratio.

There is shown in FIGURE 1b an EDTV signal of the present invention on an EDTV receiver. The EDTV display 18 has a 16:9 aspect ratio. The picture portion 14 of the EDTV signal fills the entire EDTV display 18. The border portions 16 are not seen on the EDTV display 18.

FIGURE 1c shows a NTSC signal on an EDTV receiver of the present invention. The picture 20 of the NTSC signal has an aspect ratio of 4:3 and is displayed on the EDTV display 18 with vertical borders 22. Although two vertical borders 22 and two horizontal borders 16 are shown, it is understood that a single border may be used in each case, if preferred.

There is shown in FIGURE 2 the format of a progressively scanned source image for the EDTV transmission system. Unlike the NTSC system which uses interlaced scanning, the EDTV system uses a progressive scanning of the source image from the top of the image to the bottom of the image. Source image 24 is composed of a picture portion 26 which has a 16:9 aspect ratio and border portions 28 which fill out source image 24 to an aspect ratio of 4:3. Picture portion 26 is composed of 360 video lines and the border area is composed of 120 video lines. The source image also contains a 45 line vertical retrace portion 30. Picture portion 26 and border portions 28 are scanned in the horizontal direction for a period of 26 microseconds. An additional 5.8 microseconds is used for horizontal retrace 32. The progressively scanned source image 24 must be processed to become compatible with the NTSC standard. FIGURE 3 shows the source image 24 of FIGURE 2 processed to that standard. Source image 34 has a picture portion 36 with a 16:9 aspect ratio and border portions 38 which fill out source image 34 to a 4:3 aspect ratio. Picture portion 36 has 180 lines with the border area having 60 lines. This is one-half the number of lines seen in source image 24 of FIGURE 2. The horizontal scan time of source image 34 is 52 microseconds which is twice the horizontal scan time of source image 24 in FIGURE 2. The processing of source image 24 of FIGURE 2 into source image 34 of FIGURE 3 is accomplished with a line differential generation, scan conversion, and vertical down-sampling circuit shown in FIGURE 4 and described below.

FIGURE 4 shows a block schematic diagram

which contains a scan conversion and vertical down-sampling circuit producing a main signal that matches source image 34 of FIGURE 3. The main signal contains only one-half of the information originally in source image 24 of FIGURE 2. The line differential generation circuitry of FIGURE 4 provides a line differential signal which contains the information missing in the main signal. The main signal plus the line differential signal contain all of the information originally contained in source image 24 of FIGURE 2.

Source image 24 of FIGURE 2 is read into a vertical low-pass prefilter 40 to remove the unwanted high-frequency components present in the original signal that can cause aliasing following the subsequent vertical down sampling. The signal from prefilter 40 is applied to line differential generation circuit 42. The signal enters circuit 42 on line 44 and is applied to a three line delay 46. The output of three line delay 46 is then applied to line memory 48 and then to line memory 50. At this point a signal from three different lines (a, b, and c) appears at three different points in the circuit. The signal for line a appears at junction 52, the signal for line b appears at junction 54, and the signal for line c appears at junction 56. The signal from line a at junction 52 is applied to divider circuit 58 where the signal is divided in half. The signal from line c at junction 56 is applied to another divider circuit 60 where it also is divided in half. The signal representative of one-half of a and the signal representative of one-half of c are applied to adder circuit 62. The signal from line b at junction 54 is subtracted from the added signals representative of one-half and one-half c. The signal from adder circuit 62 is representative of the difference between the signal of line b and the average of the signals on lines a and c. This line differential signal is applied over line 64 to scan conversion and vertical down-sampling circuit 66. The original signal from prefilter 40 is also applied to scan conversion and vertical-down-sampling circuit 66.

Circuit 66 has two channels. Main channel 68 is used to scan convert and vertical down-sample the original signal, and the line differential channel 70 is used to do the same to the line differential signal. Since both channels operate in an identical manner only one will be described in detail. The original signal from prefilter 40 is applied to main channel 68 at switch 72. Switch 72 is a four position switch which switches between line memories 74 and 76 and open positions. Therefore, only every other line is read into a line memory. Each line is read in at the scan rate of 26 microseconds per line. When switch 72 is at position 1 line a is read into line memory 74. Switch 72 then switches to position 2 and line b is deleted. Then switch 72 moves to position 3 where line c is read into line memory 76. Switch 72 then switches to position 4 and line d is deleted. The switch then moves to position 1 and the cycle starts again with line e. Each line

is read out of the line memory at 52 microseconds per line. Switch 78 moves from position 1 where line a is read out and then to position 2 where line c is read out and then back to position 1 where line a is read out and so forth. The output from switch 78 is the I signal.

The line differential signal is scan converted and vertical down-sampled in the same manner as the main signal. Switch 80, line memories 82 and 84, and switch 86 work in concert to produce a line differential signal which has a scan time of 52 microseconds per line. Again, every other line is deleted, but the line differential channel 70 deletes the lines that the main channel preserves. The line differential signal is the Q signal.

There is shown in FIGURE 5 a block schematic diagram of the pre-modulator components of an EDTV broadcast signal transmission system. The components of FIGURE 5 provide for coding a part of the Q signal into the border areas of the I signal. The border areas are only one-third the size of the picture area so three frames (complete vertical scans) are required in order to contain information from the picture portion of the Q signal in the I signal border and, thus the Q signal is updated only once for every three vertical scans. For this reason, a motion detector is provided to detect motion in the Q signal. If motion is detected, then that portion of the Q signal is blanked. There is also provided a time compression and multiplexing circuit for the color components of the Q signal. This circuit allows the color components to be placed into the border areas of the luminance component of the Q signal. Again, since these areas are only one-third the size of the picture area, these color components are processed by the motion detector circuitry. Various delay compensation circuits are provided to compensate for the processing of the components of the I and Q signals.

The Q signal is divided into its luminance component (Y) and its color components (u, v). The color components are applied from the circuit shown in FIGURE 4 to low pass filters 88. Low pass filters 88 are band limited to 0-0.6 MHz. The luminance component is applied to low pass filter 90 which has a band pass of 0-1.25 MHz. The low pass filtered color components are applied to motion detector 92. The low pass filtered luminance component is applied to a subtractor circuit 91 which also is an input of the luminance signal. The output of subtractor circuit 91 is a high pass filtered luminance component. This high pass filtered component is also applied to motion detector 92. Motion detector 92 monitors the components applied to it for indications of motion. During those portions of the signals where motion is indicated, motion detector 92 produces a motion signal to indicate motion in the picture. This motion signal controls switch 94 to blank the color and luminance component signals so that they are deleted from later processings. If there is no motion detected by motion

detector 92 the color and luminance components of the signal are applied to field store 96 which can store 60 lines of signal information. The luminous component of the Q signal is then applied to adder circuit 98, and a pattern generator 100 is also to be applied to adder 98. Adder 98 and generator 100 provide a pattern for the border areas of the displayed signal to prevent distraction to the viewer of the Q signals encoded in the border of the image. The output of adder circuit 98 is applied to switch 102 which controls the output to in-phase modulator 104.

The color and luminance components of the I signal are applied to delay compensation circuit 106 and then to switch 102. Time period A is the time period when the picture portion of the source image is being sent to the modulator and time period B is the time period when the border portion of the source image is being sent to the modulator. Switch 102 allows the I signal components to be sent to the in-phase modulator 104 for 180 lines when the switch 102 is in position A (referred to as time period A). When switch 102 is in position B (referred to as time period B) the high pass filtered luminance component of the Q signal and the pattern signal is sent to the in-phase modulator 104 for a total of 60 lines per scan. The color components of the I signal are applied to color encoder 108. The color components are then combined with the luminance component of the I signal in adder circuit 110 before being applied to in-phase modulator 104. The high pass filtered luminance component of the Q signal plus the pattern signal is applied from adder circuit 98 through switch 102 to adder circuit 110 and then applied to in-phase modulator 104.

The low pass filtered color components of the Q signal are applied from field store 96 to time compression and multiplexing circuit 112. After being time compressed and multiplexed, the color components of the Q signal are applied to position B of switch 114. Position B of switch 114 is activated only during the 60 lines of border transmission. The low pass filtered luminance component of the Q signal is applied from low pass filter 90 to delay compensation 116 and then to point A of switch 114. When switch 114 is in the A position, the luminance component of the Q signal is applied to quadrature modulator 118.

Therefore the circuitry shown in FIGURE 5 provides a means for placing a part of the Q signal into the border areas of the I signal. In addition, the color components of the Q signal are placed into the border areas of the luminance component of the Q signal. A motion detector blanks the portions of the Q signal that are placed into the border areas when motion is detected. After carrier modulation, the I and Q signals are then transmitted for reception by television receivers.

There is shown in FIGURE 6 a block schematic diagram for the RF, IF, and detector portions of an EDTV receiver. These portions operate in a manner

similar to similar circuits in NTSC receivers except that there is an additional IF amplifier (and associated circuitry) to process the received quadrature signal. The transmitted signal is received by the receiver at antenna 120. The signal is then sent from antenna 120 to tuner 122. Tuner 122 then applies the signal to sound IF amplifier 124, in-phase IF amplifier 126, and quadrature IF amplifier 128. The signal from in-phase IF amplifier 126 is applied to phase lock loop oscillator 130 which applies a synchronizing signal to sound synchronous detector 132, in-phase synchronous detector 134, and quadrature synchronous detector 136. In-phase synchronous detector 134 applies the in-phase signal to I signal demodulator 138. Quadrature synchronous detector 136 applies the quadrature signal to Q signal demodulator 140. The demodulated signals are then applied to further signal processing circuits of the EDTV receiver.

FIGURE 7 is a block schematic diagram of the signal processing circuits in an EDTV receiver. These circuits restore the information, in the Q signal, that was deleted from the source image in order to produce the I signal. FIGURE 7a shows the reconstruction of the I and Q signals and FIGURE 7b shows the combining of the I and Q signals into a signal suitable for display. In FIGURE 7a, the signals from in-phase and quadrature demodulators are time gated according to the same switch control sequence as is shown in FIGURE 5. During time period A, the in-phase signal is processed by the comb filter 142 and the color demodulator 144 and results in the I signals. Also, during time period A, the signal from the quadrature detector is the low pass filtered luminance line differential component. This component is applied to adder circuit 146 where it is added to high pass filtered luminance line differential components. During B time periods, the field store 148 is fed by the high pass filtered luminance component of the Y signal from high pass filter 150 to update luminance portions of the picture. During time period A, the entire field store is read out providing a complete luminance component of the Q signal. In addition, the color components of the Q signal are read into a time expansion and demultiplexer circuit 152. Thus, the Q signals have been reassembled into their proper locations for the picture.

For NTSC signal reception, the switch 154 is left in position A, and the signals I represent the normal NTSC components. There would be no Q signals developed in this case. Following this case into FIGURE 7b, the I signal goes directly to the scan conversion block 156. The missing line information for the progressive scan generation is provided by a median filter circuit 158. Its decision logic determines whether to output adjacent line or previous field information. Scan converter 156 uses a time compression signal from clock controller 160 to compress the horizontal time of the signal.

For EDTV signals, the I and Q signals are expanded vertically in field store blocks 162 and 163 and vertical filters 164 and 165; adjacent line average circuit 166 generates an adjacent line average which is applied to adder circuit 168. The adjacent line average is subtracted from the Q signals at adder circuit 168 to form the missing line information that was originally deleted from the source signal. The scan converter does not perform horizontal time compression in this case so that the picture extends to the full width of the screen.

FIGURE 8a is a block schematic diagram of the Field Store and Vertical Filter blocks (162 and 164, 163 and 165) shown in FIGURE 7b. The field store and vertical filter block for both I and Q signals are identical. The circuitry provides a means for expanding three lines of input signal into four lines of output signal. The three lines are averaged in such a way that there is a gradation between groups of three lines. The input signal, either I or Q, is time gated through switch 184 alternately into either odd field store 186 or even field store 188 during the picture portion of the signal. As one field is being read in through switch 184, the other field is being read out through switch 190. The read out of the field stores are controlled to read three video lines and then to produce a null video line signal. Video line signals are applied to one-line delay 194 and then to one-line delay 196.

When three lines have been applied, one line signal (X) appears at junction 198, a second line signal (Y) appears at junction 200, and the third line signal (Z) appears at junction 202. Signal X is applied to quarter divider circuit 204; the X/4 signal is then applied to adder circuit 206 and adder circuit 208. Signal Y is applied to three-quarter divider circuit 210, half divider circuit 212, and position 1 of commutator switch 214. The 3Y/4 signal from circuit 210 is applied to adder circuit 206 where it is added to the X/4 signal to produce a signal equal to $3Y/4 + X/4$. This signal is then applied to position 2 of commutator switch 214. The Y/2 signal from circuit 212 is applied to adder circuit 216. Signal Z is applied to three-quarter divider circuit 218 and half divider circuit 220. The 3Z/4 signal is applied to adder circuit 208 where it is added to the X/4 signal to produce a signal equal to $3Z/4 + X/4$ which is then applied to position 4 of commutator switch 214. The Z/2 signal is applied to adder circuit 216 where it is added to the Y/2 signal to produce a signal equal to $Y/2 + Z/2$ which is then applied to position 3 of commutator switch 214. Commutator switch 214 sequentially applies the signals at positions 1, 2, 3, and 4 to output 222. The signal from output 222 is then processed further by the remaining circuitry of FIGURE 7b.

In order to facilitate an understanding of the operation of vertical filter 164 or 165, FIGURE 8b shows the lines that appear at junctions 199, 200, and 202

(signals X, Y, and Z respectively). At time 1, video line a is read from even field store 188 to junction 198 (X); at time 2, video line b is read to junction 198 (X) and video line a is read to junction 200 (Y); at time 3, video line c is read to junction 198 (X), video line b is read to junction 200 (Y), and video line a is read to junction 202 (Z). As each new video line is read onto junction 198, the preceding lines are read onto next junctions. Every fourth line (d, h & l) is a null line, which passes through the circuitry in the same manner as a video line from field store 188 (or 186).

The signal appearing at commutator switch 214 position 1 is Y; position 2 has $3Y/4 + X/4$, position 3 has $Y/2 + Z/2$; and position 4 has $3Z/4 + X/4$. The commutator switch 214 is synchronized so that the video line immediately after the null line is at junction 200 when switch 214 is at position 1. FIGURE 8b shows that the signal at output 222 at time 6 is video line e. At time 7, the output is a video line that is representative of three-fourths of video line f plus one-fourth video line g. At time 8, the output is representative of one-half f and one-half g. At time 9, the output is representative of three-fourths g and one-fourth i. At time 10, the cycle begins again and the output is video line i. At no time does a null video line appear at output 222. Thus, vertical filter 164 and field store 162 operate to expand each three video lines into four video lines with a gradation between groups of three video lines.

FIGURE 9 shows a block schematic diagram of a simplified EDTV transmitter. The blocks operate in a manner similar to the blocks of the same name shown in FIGURE 5. The color components of the Q signal are eliminated prior to transmission. Also, there is no use of the border areas to transmit the luminance portion of the Q signal. The color component of the I signal is applied to color encoder 170 and then to adder circuit 172. The luminance component of the I signal is applied directly to adder circuit 172. The output of adder circuit 172 is then applied to in-phase modulator 174. The luminance component of the Q signal is applied to a 0-1.25 MHz low pass filter 176 which produces a low pass filtered luminance component of the Q signal which is then applied to the quadrature modulator 178. Since the human eye cannot resolve fine color detail, it is not necessary to improve the vertical color resolution over the standard NTSC amount. This circuit shows how the circuitry of FIGURE 5 may be greatly simplified.

There is shown in FIGURE 10 a block schematic diagram of a simplified EDTV receiver. The blocks operate in a manner similar to the blocks of the same name shown in FIGURE 7. Using the simplified signal processed by the circuitry of FIGURE 9, the I signals are applied directly to comb filter 180 where they are separated into the luminance and color components. The color components are then applied to color demodulator 182. This then produces the completed I

signal. Since there is no Q signal in the I components, the luminance component of the Q signal may be directly applied to the rest of the circuitry of the receiver without further processing. Therefore, the circuitry of an EDTV receiver may be greatly simplified.

It may be seen from the foregoing that the present invention provides a means for producing, transmitting, receiving, and displaying an extended definition television signal within the standard NTSC bandwidth. This EDTV signal may be received and displayed by NTSC receivers as well as EDTV receivers. In addition, the EDTV receivers may also receive and display standard NTSC signals. The EDTV signal displayed on an EDTV display has much better vertical resolution than the standard NTSC signal.

Claims

1. A method of encoding extended definition television signals in which a wide aspect ratio picture and at least one horizontal border conveying enhancement signals together constitute a standard aspect ratio picture, characterized by the steps of:
 - processing (42) source image signals to generate line differential enhancement signals (Q) from said source image signals; and
 - inserting (102, B) said line differential enhancement signals (Q) into said at least one horizontal border.
2. An encoding method as claimed in claim 1, wherein said line differential enhancement signals are processed (90, 91) to contain only frequency components above a given frequency.
3. An encoding method as claimed in claim 1, wherein said wide aspect ratio picture is modulated (104) as an in-phase component of a picture carrier, a low-frequency part (90) of said line differential enhancement signals is encoded (118) as a quadrature component of said picture carrier, and a high-frequency part (91) of said line differential enhancement signals is inserted (102, B) into said at least one horizontal border.
4. An encoding method as claimed in claim 1, wherein said inserting step includes generating a masking signal (100), and combining (98) said masking signal and said line differential enhancement signals to produce a combined border signal for insertion (102, B) into said at least one horizontal border.
5. A device for decoding extended definition television signals in which a wide aspect ratio picture and at least one horizontal border conveying en-

(signals X, Y, and Z respectively). At time 1, video line a is read from even field store 188 to junction 198 (X); at time 2, video line b is read to junction 198 (X) and video line a is read to junction 200 (Y); at time 3, video line c is read to junction 198 (X), video line b is read to junction 200 (Y), and video line a is read to junction 202 (Z). As each new video line is read onto junction 198, the preceding lines are read onto next junctions. Every fourth line (d, h & l) is a null line, which passes through the circuitry in the same manner as a video line from field store 188 (or 186).

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signal. Since there is no Q signal in the I components, the luminance component of the Q signal may be directly applied to the rest of the circuitry of the receiver without further processing. Therefore, the circuitry of an EDTV receiver may be greatly simplified.

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 - inserting (102, B) said line differential enhancement signals (Q) into said at least one horizontal border.
2. An encoding method as claimed in claim 1, wherein said line differential enhancement signals are processed (90, 91) to contain only frequency components above a given frequency.
3. An encoding method as claimed in claim 1, wherein said wide aspect ratio picture is modulated (104) as an in-phase component of a picture carrier, a low-frequency part (90) of said line differential enhancement signals is encoded (118) as a quadrature component of said picture carrier, and a high-frequency part (91) of said line differential enhancement signals is inserted (102, B) into said at least one horizontal border.
4. An encoding method as claimed in claim 1, wherein said inserting step includes generating a masking signal (100), and combining (98) said masking signal and said line differential enhancement signals to produce a combined border signal for insertion (102, B) into said at least one horizontal border.
5. A device for decoding extended definition television signals in which a wide aspect ratio picture and at least one horizontal border conveying en-



hancement signals together constitute a standard aspect ratio picture, characterized by:

first means (154, 142) for separating picture signals with said wide aspect ratio from said extended definition television signals;

second means (154, 150) for separating line differential enhancement signals from said extended definition television signals;

means (162-165, 168, 156) for combining said line differential enhancement signals with said wide aspect ratio picture signals thereby generating enhanced picture signals defining an enhanced picture having said wide aspect ratio.

6. A decoding device as claimed in claim 5, wherein said second separating means (154, 150) comprise means for extracting (154, 150) said line differential enhancement signals from said at least one horizontal border, said line differential enhancement signals in said at least one horizontal border containing only frequency components above a given frequency.
7. A decoding device as claimed in claim 5, wherein said enhancement signals conveyed in said at least one horizontal border comprise a masking signal combined with said line differential enhancement signals, said second separating means comprise means for decomposing said enhancement signals to furnish said line differential enhancement signals.
8. A decoding device as claimed in claim 5, wherein:
 - said first separating means comprise an in-phase demodulator (138); and
 - said second separating means comprise a quadrature-phase demodulator (140) for furnishing a low-frequency part of said line differential enhancement signals, and means (154, 150) coupled to said in-phase demodulator (138) for extracting a high-frequency part of said line differential enhancement signals from said at least one horizontal border.
9. A television display apparatus comprising a display screen and a decoding device as claimed in claim 5, wherein said combining means (162-165, 168, 156) comprise expansion means (162-165) for vertically expanding at least the picture of said wide aspect ratio picture signals when an extended definition television signal has been received to produce a wide aspect ratio expanded television picture of sufficient height to fill said display screen, and means (168) for adding said line differential enhancement signals to said wide aspect ratio expanded television picture.
10. A television display apparatus as claimed in claim

9, wherein said expansion means (162-165, 156) comprise:

means (156) for horizontally expanding said picture by scanning each scan line of the picture across the horizontal width of said display screen;

means (162, 163) for vertically expanding said picture by adding one additional horizontal scan line for every selected number of scan line in said picture; and

filter means (164, 165) for filtering the scan lines of said picture including the additional scan lines added by said vertical expanding means, to produce a smoothed picture, whereby said filtering substantially prevents picture distortion in the vicinity of the additional scan lines in said picture.

Patentansprüche

1. Fernsehsystem mit vergrößerter Auflösung, wobei ein Bild mit großen Seitenverhältnis und wenigstens ein horizontaler Rand, der Vergrößerungssignale transportiert, zusammen ein Bild mit einem genormten Seitenverhältnis bilden, gekennzeichnet durch die nachfolgenden Verfahrensschritte:
 - das Verarbeiten (42) der Ausgangsbildsignale zum Erzeugen von Zeilendifferenzverbesserungssignalen (Q) aus den genannten Ausgangsbildsignalen; und
 - das Einfügen (102, B) der genannten Zeilendifferenzverbesserungssignale (Q) in den genannten wenigstens einen Horizontalen Rand.
2. Codierungsverfahren nach Anspruch 1, wobei die genannten Zeilendifferenzverbesserungssignale erzeugt werden (90, 91) um nur Frequenzanteile über einer bestimmten Frequenz zu enthalten.
3. Codierungsverfahren nach Anspruch 1, wobei das Bild mit großem Seitenverhältnis als gleichphasiger Anteil eines Bildträgers (104) moduliert wird, wobei ein Niederfrequenzteil (90) der genannten Zeilendifferenzverbesserungssignale als Quadraturanteil der genannten Bildträgers codiert wird, und ein Hochfrequenzteil (91) der genannten Zeilendifferenzverbesserungssignale in den genannten wenigstens einen horizontalen Rand eingefügt wird (102, B).
4. Codierungsverfahren nach Anspruch 1, wobei der genannte Einfügungsschritt das Erzeugen eines Maskierungssignals (100) und das Kombinieren (98) des genannten Maskierungssignals zum Einfügen (102, B) in den genannten wenig-



stens einen horizontalen Rand umfaßt.

5. Anordnung zum Decodieren von Fernsehsignalen mit verbesserter Auflösung, wobei ein Bild mit großem Seitenverhältnis und wenigstens einem horizontalen Rand, der Verbesserungssignal transportiert, zusammen mit einem Bild mit einem Standardseitenverhältnis bildet, gekennzeichnet durch:

erste Mittel (154, 142) zum Trennen von Bildsignalen mit dem genannten großen Seitenverhältnis von den genannten Fernsehsignalen mit verbesserter Auflösung;

zweite Mittel (154, 150) zum Trennen von Zeilendifferenzverbesserungssignalen von den genannten Fernsehsignalen mit verbesserter Auflösung;

Mittel (162-165, 168, 156) zum Kombinieren der genannten Zeilendifferenzverbesserungssignale mit den genannten Bildsignalen mit großem Seitenverhältnis, wodurch verbesserte Bildsignale erzeugt werden, die ein verbessertes Bild mit dem genannten großen Seitenverhältnis definieren.

6. Decodieranordnung nach Anspruch 5, wobei die genannten zweiten Trennmittel (154, 150) Mittel enthalten zum Extrahieren (154, 150) der genannten Zeilendifferenzverbesserungssignale aus dem genannten einen horizontalen Rand, wobei die genannten Zeilendifferenzverbesserungssignale in dem genannten wenigstens einen horizontalen Rand nur Frequenzanteile über einer bestimmten Frequenz enthalten.

7. Decodieranordnung nach Anspruch 5, wobei die genannten in dem genannten wenigstens einen horizontalen Rand transportierten Verbesserungssignale ein Maskierungssignal kombiniert mit den genannten Zeilendifferenzverbesserungssignalen enthalten, wobei die genannten zweiten Trennmittel Mittel enthalten zum Auseinanderlösen der genannten Verbesserungssignale zum Liefern der genannten Zeilendifferenzverbesserungssignale.

8. Decodieranordnung nach Anspruch 5, wobei:
die genannten ersten Trennmittel einen phasengleichen Demodulator (138) aufweisen und

die genannten zweiten Trennmittel einen Quadraturphasendemodulator (140) aufweisen zum Liefern eines Niederfrequenzteils der genannten Zeilendifferenzverbesserungssignale und Mittel (154, 150), die mit dem genannten phasengleichen Demodulator (138) gekoppelt sind zum Extrahieren eines Hochfrequenzteils der genannten Zeilendifferenzverbesserungssignale

aus dem genannten wenigstens einen horizontalen Rand.

9. Fernseh wiedergabeapparat mit einem Wiedergabeschirm und einer Decodieranordnung nach Anspruch 5, wobei die genannten Kombiniermittel (162-165, 168, 156) Expansionsmittel (162-165) aufweisen zur vertikalen Expansion von wenigstens dem Bild der genannten Signale mit dem großen Seitenverhältnis wenn ein Fernsehsignal mit verbesserter Auflösung empfangen wurde zum Erzeugen eines Fernsehbildes ausreichender Höhe mit einer großen Seitenverhältnis, und Mittel (168) zum Addieren der genannten Zeilendifferenzverbesserungssignale zu dem genannten Fernsehbild mit großem Seitenverhältnis.

10. Fernseh wiedergabegerät nach Anspruch 9, wobei die genannten Expansionsmittel (162-165, 156) die folgenden Mittel aufweisen:

Mittel (156) zur horizontalen Expansion des genannten Bildes, durch Abtasten jeder Abtastzeile eines Bildes über die horizontale Breite des genannten Wiedergabeschirms,

Mittel (162, 163) zur vertikalen Expansion des genannten Bildes durch Addierung einer einzigen zusätzlichen horizontalen Abtastungszeile für jede selektierte Anzahl Abtastzeilen in dem genannten Bild, und

Filtermittel (164, 165) zum Filtern der Abtastzeilen des genannten Bildes einschließlich der zusätzlichen Abtastzeilen, die durch die genannten vertikalen Expansionsmittel addiert wurden, zum Erzeugen eines glatten Bildes, wobei diese Filterung im wesentlichen Bildverzerrung in der Nähe der zusätzlichen Abtastzeilen in dem genannten Bild vermeiden.

Revendications

1. Procédé de codage de signaux de télévision à définition étendue dans lequel une image de rapport largeur:hauteur large et au moins une bordure horizontale acheminant des signaux d'amélioration constituent ensemble une image de rapport largeur:hauteur standard, caractérisé en ce que :

on traite (42) des signaux d'image source pour générer des signaux d'amélioration différentiels de lignes (Q) à partir desdits signaux de l'image source, et

on insère (102, B) lesdits signaux d'amélioration différentiels de lignes (Q) dans ladite au moins une bordure horizontale.

2. Procédé de codage selon la revendication 1, dans lequel lesdits signaux d'amélioration diffé-



rentiels de lignes sont traités (90, 91) en sorte de contenir uniquement des composantes de fréquence au-dessus d'une fréquence donnée.

3. Procédé de codage selon la revendication 1, dans lequel ladite image de rapport largeur:hauteur large est modulée (104) sous la forme d'une composante en phase d'une porteuse d'image, une partie de basse fréquence (90) desdits signaux d'amélioration différentiels de lignes est codée (118) sous la forme d'une composante de quadrature de ladite porteuse d'image, et une partie de haute fréquence (91) desdits signaux d'amélioration différentiels de lignes est insérée (102, B) dans ladite au moins une bordure horizontale. 5 10 15
4. Procédé de codage selon la revendication 1, dans lequel ledit stade d'insertion consiste à générer un signal de masquage (100) et à combiner (98) ledit signal de masquage et lesdits signaux d'amélioration différentiels de lignes pour produire un signal de bordure combiné pour insertion (102, B) dans ladite au moins une bordure horizontale. 20 25
5. Dispositif de décodage pour des signaux de télévision à définition étendue dans lequel une image de rapport largeur:hauteur large et au moins une bordure horizontale acheminant des signaux d'amélioration constituent ensemble une image de rapport largeur:hauteur standard, caractérisé par : 30
 - des premiers moyens (154, 142) pour séparer des signaux d'image présentant ledit rapport largeur:hauteur large desdits signaux de télévision à définition étendue; 35
 - des deuxièmes moyens (154, 150) pour séparer des signaux d'amélioration différentiels de lignes desdits signaux de télévision à définition étendue, et 40
 - des moyens (162-165, 168, 156) pour combiner lesdits signaux d'amélioration différentiels de lignes avec lesdits signaux d'image à rapport largeur:hauteur large en sorte de générer des signaux d'image améliorés définissant une image améliorée ayant ledit rapport largeur:hauteur large. 45
6. Dispositif de décodage selon la revendication 5, dans lequel lesdits deuxièmes moyens de séparation (154, 150) comprennent des moyens pour extraire (154, 150) lesdits signaux d'amélioration différentiels de lignes d'au moins ladite bordure horizontale, lesdits signaux d'amélioration différentiels de lignes dans ladite au moins une bordure horizontale ne contenant que des composantes de fréquence au-dessus d'une fréquence 50 55

donnée.

7. Dispositif de décodage selon la revendication 5, dans lequel lesdits signaux d'amélioration acheminés dans ladite au moins une bordure horizontale comprennent un signal de masquage combiné auxdits signaux d'amélioration différentiels de lignes, lesdits deuxièmes moyens de séparation comprenant des moyens pour décomposer lesdits signaux d'amélioration afin de fournir lesdits signaux d'amélioration différentiels de lignes.
8. Dispositif de décodage selon la revendication 5, dans lequel:
 - lesdits premiers moyens de séparation comprennent un démodulateur en phase (138), et
 - lesdits deuxièmes moyens de séparation comprennent un démodulateur en quadrature de phase (140) pour fournir une partie de basse fréquence desdits signaux d'amélioration différentiels de lignes, et des moyens (154, 150) couplés audit démodulateur en phase (138) pour extraire une partie de haute fréquence desdits signaux d'amélioration différentiels de lignes de ladite au moins une bordure horizontale.
9. Appareil d'affichage de télévision comprenant un écran d'affichage et un dispositif de décodage selon la revendication 5, dans lequel lesdits moyens de combinaison (162-165, 168, 156) comprennent des moyens d'expansion (162-165) pour dilater verticalement au moins une image desdits signaux d'image à rapport largeur:hauteur large lorsqu'un signal de télévision à définition étendue a été reçu afin de produire une image de télévision dilatée de rapport largeur:hauteur d'une hauteur suffisante pour remplir ledit écran d'affichage, et des moyens (168) pour additionner lesdits signaux d'amélioration différentiels de lignes à ladite image de télévision dilatée à rapport largeur:hauteur large.
10. Appareil d'affichage de télévision selon la revendication 9, dans lequel lesdits moyens d'expansion (162-165, 156) comprennent :
 - des moyens (156) pour dilater horizontalement ladite image en balayant chaque ligne de balayage de l'image en travers de la largeur horizontale dudit écran d'affichage;
 - des moyens (162, 163) pour dilater verticalement ladite image en ajoutant une ligne de balayage horizontale supplémentaire pour chaque nombre choisi de lignes de balayage de ladite image, et
 - des moyens de filtrage (164, 165) pour filtrer les lignes de balayage de ladite image, y compris les lignes de balayage additionnelles ajoutées par lesdits moyens de dilatation vertica-



le, pour produire une image uniformisée, ledit filtrage empêchant sensiblement les distorsions au voisinage des lignes de balayage supplémentaires de ladite image.

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