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(54) **METHOD OF AUDIO DATA TRANSMISSION AND SYSTEM THEREOF**

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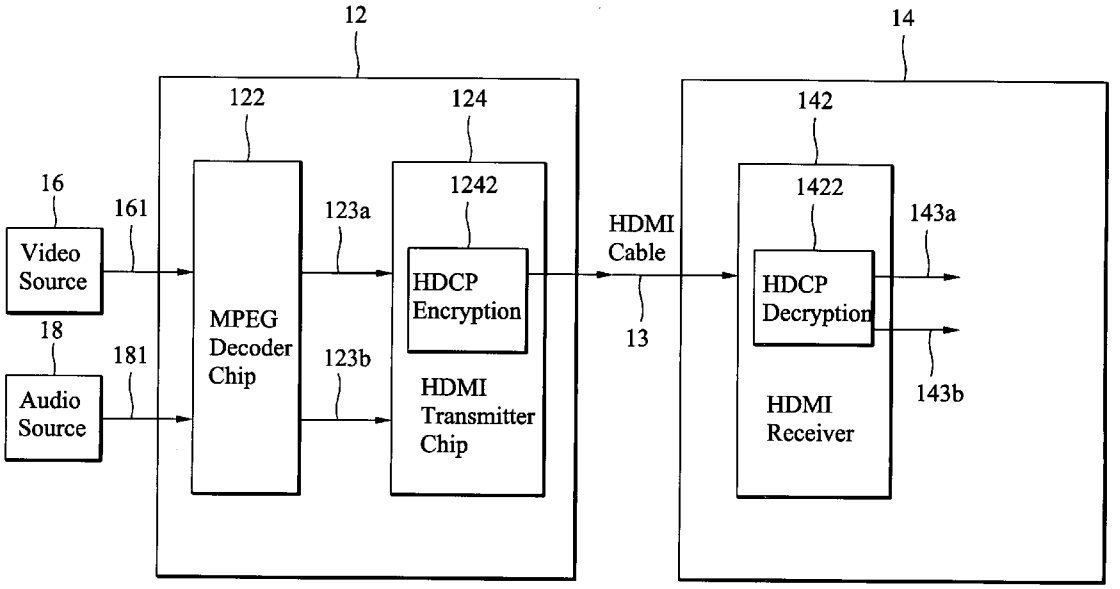
(57) **ABSTRACT**

In an embodiment, a transmitter generates a self-generated video signal when retrieving only audio input signal from an audio source to replace an video input signal expected by the HDMI system. In another embodiment, a transmitter sets a flag when retrieving only an audio input signal, wherein the flag configures preamble transmitted in control periods to allow audio data to be transmitted to a receiver without incorporated with video data.



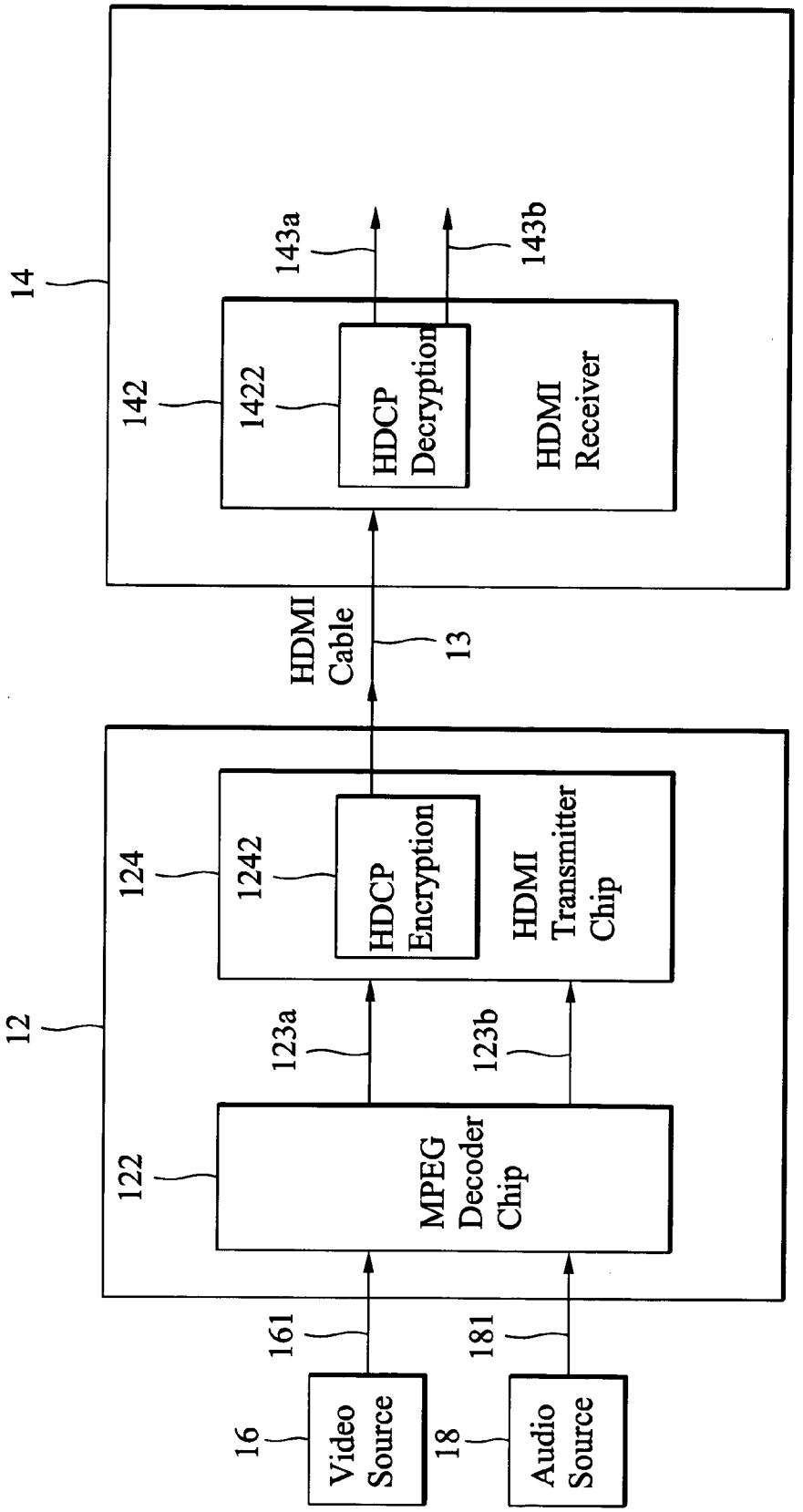

14
143a
143b
142
1422
HDCP Decryption
HDMI Receiver
HDMI Cable
13
12
124
1242
HDCP Encryption
HDMI Transmitter Chip
123a
123b
122
MPEG Decoder Chip
161
181
16
Video Source
18
Audio Source

FIG. 1

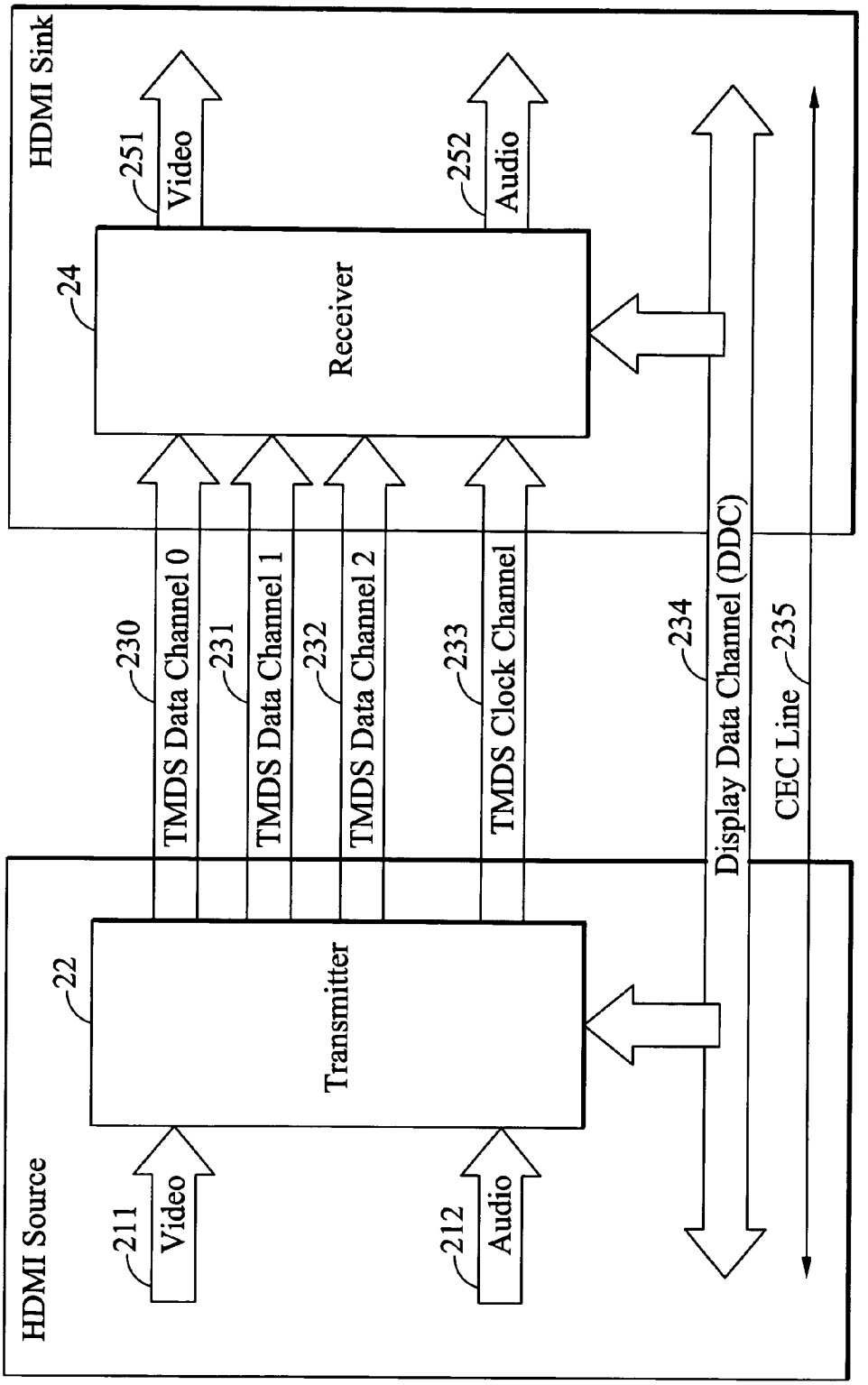

HDMI Sink
24
Receiver
251
Video
252
Audio
230
TMDS Data Channel 0
231
TMDS Data Channel 1
232
TMDS Data Channel 2
233
TMDS Clock Channel
234
Display Data Channel (DDC)
235
CEC Line
HDMI Source
22
Transmitter
211
Video
212
Audio

FIG. 2

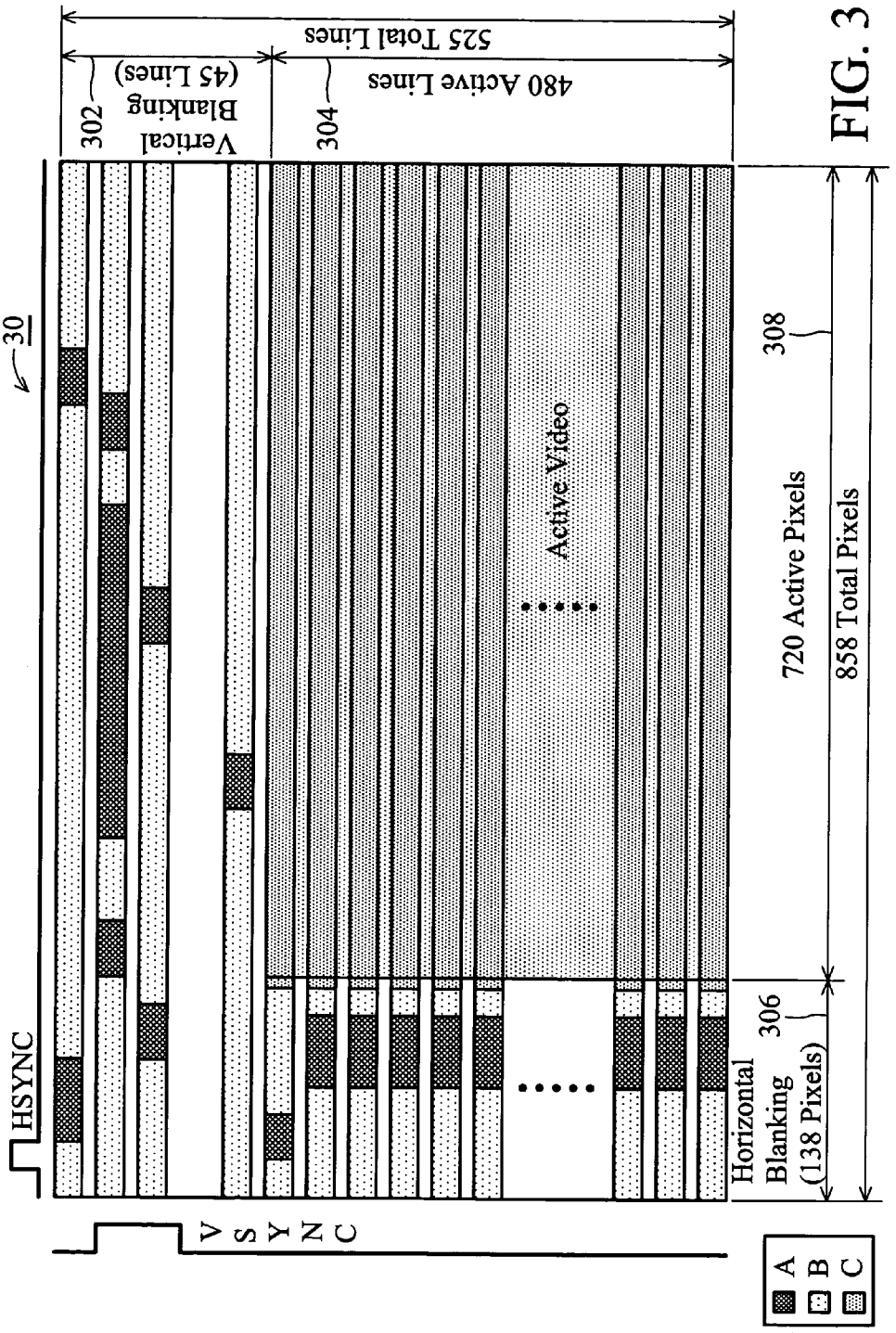

525 Total Lines
480 Active Lines
Vertical Blanking (45 Lines)
302
304
30
HSYNC
VSYNC
Active Video
308
720 Active Pixels
858 Total Pixels
306
Horizontal Blanking (138 Pixels)
A
B
C

FIG. 3

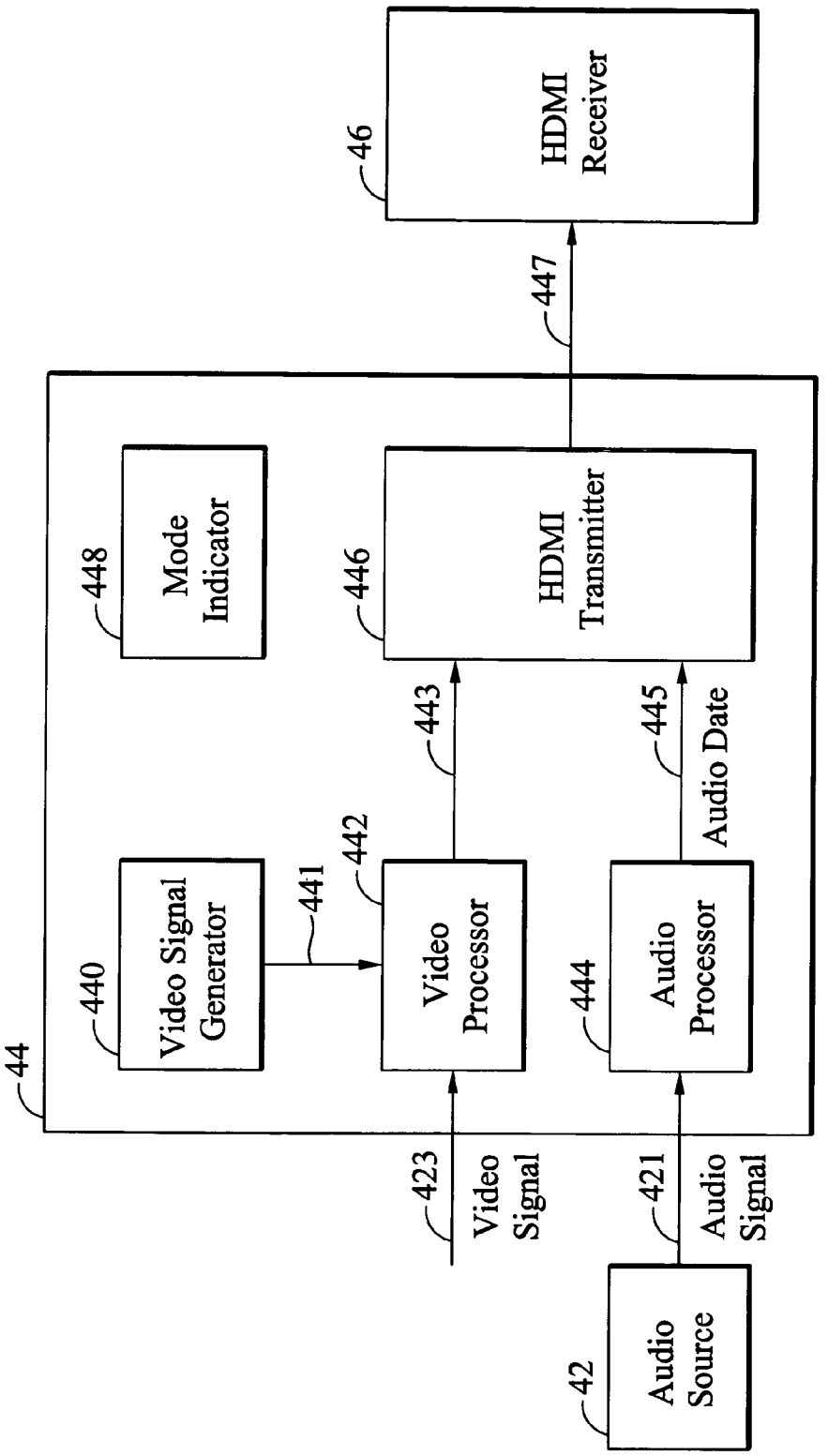

46
HDMI Receiver
447
448
Mode Indicator
446
HDMI Transmitter
443
445
Audio Date
442
441
440
Video Signal Generator
Video Processor
444
Audio Processor
44
423
Video Signal
421
Audio Signal
42
Audio Source

FIG. 4A

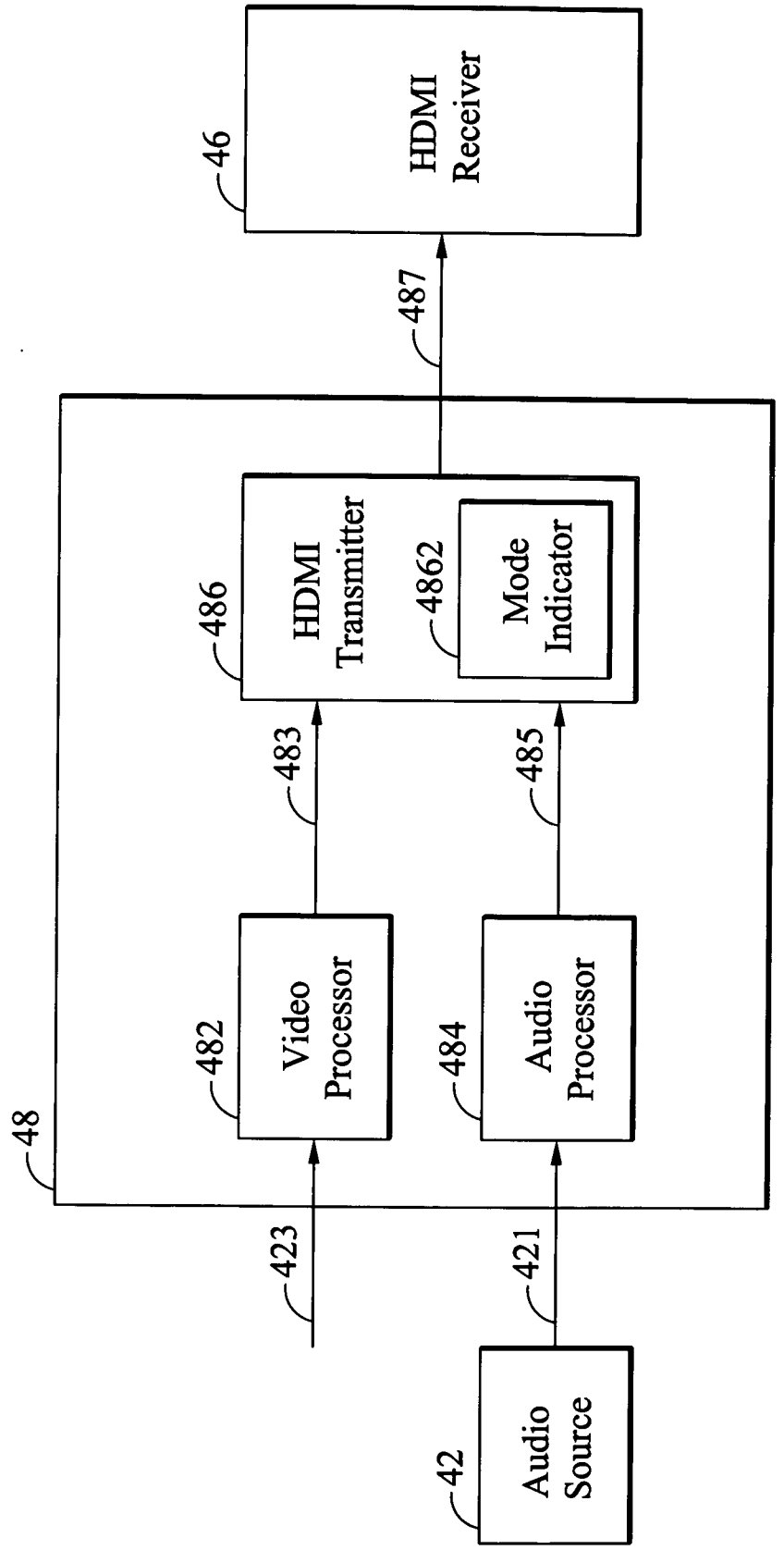

HDMI Receiver
46
487
HDMI Transmitter
486
Mode Indicator
4862
483
485
Video Processor
482
Audio Processor
484
48
423
421
Audio Source
42

FIG. 4B

METHOD OF AUDIO DATA TRANSMISSION AND SYSTEM THEREOF

BACKGROUND

[0001] The invention relates to high-definition multimedia interface (HDMI), and more specifically, to methods and systems for transmission of audio data that is originally not associated with video data using HDMI.

[0002] HDMI, an industry-supported, uncompressed, all-digital audio/video interface, provides an interface between a source device, such as a set-top box, digital video disc (DVD) player, computer, or a digital-video home system (D-VHS), and a destination device, such as a digital television (DTV), projector, plasma panel or a liquid crystal display (LCD) display. HDMI integrates audio and video information into a single digital interface. HDMI development is overseen by the HDMI Working Group, including Hitachi, Panasonic, Philips, Sony, Thomson (RCA), Toshiba, and Silicon Image. LLC, a subsidiary of Intel, as developed High-bandwidth Digital Content Protection (HDCP) for HDMI, providing a secure audio/video interface that meets the security requirements of content providers and system operators.

[0003] As an example shown in **FIG. 1**, a DVD player **12** is connected to a digital television or monitor **14** via an HDMI cable **13**. A DVD player **12** comprises an MPEG decoder chip **122** and an HDMI transmitter chip **124**. The MPEG decoder chip **122** acquires video data **161** and audio data **181** from a video source **16** and audio source **18** respectively. The HDMI transmitter chip **124** receives decoded video data **123***a* (such as 24-bit RGB) and decoded audio data **123***b* from the MPEG decoder chip **122**, and encrypts the decoded video data **123***a* and decoded audio data **123***b* in a HDCP encryption block **1242**. The encrypted HDMI data is output to the HDMI cable **13** and sent to an HDMI receiver **142** in the digital television **14**. The HDMI receiver **142** comprises a corresponding HDCP decryption block **1422** for decrypting the received HDMI data. The HDMI receiver **14** recovers the received HDMI data and outputs the recovered video data **143***a* and audio data **143***b*.

[0004] HDMI utilizes core technologies provided by the Digital Visual Interface (DVI). DVI is a 24-bit RGB interface, which utilizes transition minimized differential signaling (TMDS). TMDS is a signaling technique that produces a transition controlled, DC balanced series of characters from an input series of data bytes. In a long string of logic zeros and logic ones, bits are selectively manipulated to maintain a particular DC biased signal. A DVI link utilizes three pairs of differential digital signals, each pair carrying low voltage signals representative of the red (R), green (G), and blue (B) signal components. A fourth pair of wires carries a pixel clock signal. A serial 8-bit RGB signal carries information at a speed of up to 1.65 Gbps with an aggregate link speed of 4.95 Gbps, but an effective transfer rate of 3.96 Gbps. A 10 bit encoding scheme is utilized to minimize transitions at such high data rates.

[0005] HDMI has potential beyond the scope of DVI. The HDMI specifications allow up to 5 Gbps bandwidth, compatible with future technology expansions, as current uncompressed HD movies only require 2.2 Gbps for both multi-channel audio and video. DVI has drawbacks that can be solved by HDMI, for example, DVI does not support digital audio data and digital chrominance signals (YCbCr). HDMI is fully backward-compatible with DVI using the CEA-861 profile for DTVs, however, the limitation of DVI makes a DVI device connected to an HDMI device unable to provide audio capability. One of the most important capabilities of HDMI is the ability to carry digital multi-channel audio in addition to digital video.

[0006] HDMI has the capability to support existing high-definition video formats (720 p, 1080 i, and 1080 p). It also has the flexibility to support enhanced definition formats such as 480 p and 576 p, as well as standard definition formats such as National Television System Committee (NTSC) or Phase Alternating Line (PAL). The HDMI specifications allow for up to 8 channels of audio with 24 bits at sampling rates for up to 192 kHz, supporting all current forms of pulse code modulation (PCM) audio including DVD-Audio and compressed audio formats. HDMI allows connection from source to receiver, or receiver to display, all via one cable type for both video and audio.

SUMMARY

[0007] The invention provides methods and systems for transmission of audio data that is originally not associated with video data using High-definition Multimedia Interface (HDMI). In one embodiment, an HDMI transmitting system receives audio input signal, and self-generates video signal if the video input signal is absence. The HDMI transmitting system thus transmits audio data in data island periods and self-generated video data in video data periods. According to the HDMI specification, audio must be transmitted and played with video, such that the self-generated video data provided by the HDMI transmitting system replaces the absent input video data expected by the HDMI system. The audio data is transmitted in the data island periods within periods of horizontal or vertical blanking. Exemplary self-generated video data is a static (or still) picture, such as a logo or a trademark.

[0008] In another embodiment, an HDMI transmitting system receives an audio input signal, and sets a flag if a video input signal is not available. The HDMI transmitting system transmits audio data in data island periods within periods of horizontal or vertical blanking, and the flag configures the HDMI protocol to replace video data periods with data island periods and control periods. The flag extends horizontal or vertical blanking by configuring the beginning and end points thereof. The HDMI transmitting system can also send a signal instructing the corresponding HDMI receiver to turn off the display to conserve power.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention can be more fully understood by reading the subsequent detailed description in conjunction with the examples and references made to the accompanying drawings, wherein:

[0010] **FIG. 1** is a schematic diagram illustrating a conventional HDMI system with HDCP protection scheme.

[0011] **FIG. 2** is a block diagram of an HDMI system.

[0012] **FIG. 3** shows an exemplary TMDS period placement in a 720×480 p video frame.

[0013] **FIG. 4A** is a block diagram illustrating an embodiment of a system for audio transmission using HDMI.

[0014] **FIG. 4B** is a block diagram illustrating an embodiment of a system for audio transmission using HDMI.

DETAILED DESCRIPTION

[0015] **FIG. 2** is a block diagram of an HDMI system, comprising a plurality of sources and sinks, wherein an HDMI source denotes a device with an HDMI output, and an HDMI sink denotes a device with an HDMI input. As shown in **FIG. 2**, the HDMI cable and connectors carry four differential pairs that make up the transition minimized differential signaling (TMDS) clock channel **233** for carrying timing information for video data ("video pixel clock"), and three TMDS data channels **230~232** carrying video data **211**, audio data **212**, and auxiliary data. The auxiliary data herein includes any data that is neither video data, audio data, nor timing information for video data, for example, timing information for audio data, text data, control signals for power supply, monitor control information (such as audio volume, brightness, or power state), and non-audio or video control information.

[0016] A video electronics standard association (VESA) display data channel (DDC) **234** configures and exchanges status between a single source and a single sink. An optional consumer electronics association (CEC) protocol provides high-level control functions between all audiovisual products in a user's environment. The video pixel clock is transmitted via the TMDS clock channel **233**, and is used by the receiver **24** as a frequency reference for data recovery on the other three TMDS data channels **230~232**. In order to transmit audio data **212** and auxiliary data across the TMDS data channels **230~232**, HDMI uses a packet structure. As previously mentioned, the data can be protected with HDCP to attain higher reliability.

[0017] Various serial links for transmitting data and clock signals from a transmitter **22** to a receiver **24** are well known to those skilled in the art. One conventional serial links is known as a TMDS link, in which video data **211** are encoded and transmitted as encoded words, and the encoded video data and a video clock signal are transmitted as differential signals. The TMDS link operates in video data period, data island period, or control period. **FIG. 3** depicts an exemplary TMDS period placement in a 720×480 p video frame **30**. The active pixels of an active video line are transmitted during the video data periods, marked by pattern C in **FIG. 3**. Audio and auxiliary data is transmitted using a series of packets during data island periods, marked by pattern A. The control periods, marked by pattern B, are used when no video, audio, or auxiliary data needs to be transmitted, required between any other two periods.

[0018] As shown in **FIG. 3**, the primary data transmitted by a TMDS link are video data. The video data are not continuous, but with many blanking intervals, including vertical blanking **302** and horizontal blanking **306**. These blanking intervals provide an opportunity for audio data and auxiliary data to be transported.

[0019] A preamble at the end of each control period indicates whether the next data period is a video data period or a data island period. Each video data period and data island period starts with a leading guard band providing determination of the transition from the control period to the data period.

[0020] As shown in **FIG. 3**, audio data is transmitted during data island periods within horizontal blanking **306** and vertical blanking **302**. In conventional HDMI architecture, audio can only be transmitted along with video. The invention provides methods and systems allowing the audio data that is originally not associated with video data to be played by using an HDMI transmitter.

[0021] **FIG. 4A** is a block diagram illustrating an embodiment of a system for audio transmission using HDMI. As shown in **FIG. 4A**, an HDMI transmitting system **44** comprises an HDMI transmitter **446**, an audio processor **444**, a video processor **442**, a video signal generator **440**, and a mode indicator **448**. The HDMI transmitting system **44** receives an audio input signal **421** from an audio source **42** and a video input signal **423** from a video source (not shown). The audio processor **444** receives and processes the audio input signal **421**, such as digitizing, coding, and compressing the audio input signal **421**, and subsequently outputs audio data **445** to the HDMI transmitter **446**. The mode indicator **448**, which could be a register or a control signal in practical implementation, is used to reflect if only audio input signal **421** is available or both audio input signal **421** and video input signal **423** are available. The video processor **442** receives either the external video input signal **423** or a self-generated video signal **441** output by the video signal generator **440** in accordance with the mode indicator **448**. The video processor **442** processes the video signal, such as digitizing, coding, and compressing the video signal, and subsequently outputs video data **443** to the HDMI transmitter **446**. The self-generated video signal **441** can carry any video, for example, a static picture such as a logo or a trademark. The HDMI transmitter **446** receives both the audio data **445** and the video data **443**, and outputs an HDMI signal **447** to the HDMI receiver **46** through an HDMI cable.

[0022] **FIG. 4B** is a block diagram illustrating an embodiment of a system for audio transmission using HDMI. An HDMI transmitting system **48** comprises an HDMI transmitter **486**, an audio processor **484**, and a video processor **482**. The HDMI system **44** receives an audio input signal **421** from an audio source **42** and a video input signal **423** from a video source (not shown). The audio processor **484** receives and processes the audio input signal **421**, and subsequently outputs audio data **485** to the HDMI transmitter **486**. The HDMI transmitter **486** comprises a mode indicator **4862**, which could be a register or a control signal. The mode indicator **4862** reflects whether there is only audio input signal **421** available, or there are both audio input signal **421** and video input signal **423** available at the input of the HDMI system. The video processor **482** receives and processes the video input signal **423** and outputs video data **483** to the HDMI transmitter **486**. The HDMI transmitter **486** receives the audio data **485** and the video data **483** if the input of the HDMI system contains both audio and video signals, and outputs an HDMI signal **487** to the HDMI receiver **46** through an HDMI cable. If the input of the HDMI system contains only audio signal, the mode indicator in the HDMI transmitter **486** sets a flag, and the HDMI transmitter **486** outputs an HDMI signal **487** to the HDMI receiver **46** according to the audio data **485**. The flag configures the preamble transmitted in the control period to always arrange a data island period after each control period. The video frame thus contains only control period and data island periods. In other words, the periods of horizontal or vertical blanking are extended and the video data periods are

omitted from the video frame. In some embodiments, the flag can also signal the HDMI receiver to turn off the display since there is no video data to be played, thereby conserving power.

[0023] While the invention has been described by way of example and in terms of preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A method for transmitting audio data using a High-definition Multimedia Interface (HDMI), comprising:

receiving input data;

self-generating video data if the input data contains no video data; and

transmitting the audio data in data island periods and the self-generated video data in video data periods.

2. The method according to claim 1, wherein the self-generated video data is a static picture.

3. A method for transmitting audio data using a High-definition Multimedia Interface (HDMI), comprising:

receiving input data;

setting a flag if the input data contains no video data;

configuring preambles transmitted in control periods to arrange a data island period after each control period once the flag is set; and

transmitting the audio data in data island periods.

4. The method according to claim 3, wherein the audio data is transmitted in the data island periods within horizontal blanking or vertical blanking periods.

5. The method according to claim 4, wherein the flag extends the horizontal blanking periods by configuring beginning and end points thereof.

6. The method according to claim 4, wherein the flag extends the vertical blanking periods by configuring beginning and end points thereof.

7. The method according to claim 3, further comprising instructing an HDMI receiver to turn off a display once the flag is set.

8. An HDMI transmitting system for transmitting audio data, comprising:

an audio processor, receiving and processing an audio input signal to generate audio data;

a video signal generator, generating a self-generated video signal if a video input signal is not available;

a mode indicator, reflecting if only the audio input signal is available or both audio and video input signals are available at the input of the HDMI transmitting system;

a video processor, receiving and processing the video input signal or the self-generated video signal to generate video data according to the mode indicator; and

an HDMI transmitter, receiving the audio and video data from the audio processor and video processor respectively, and outputting an HDMI signal carrying the audio data in data island periods and the video data in video data periods, respectively.

9. The HDMI transmitting system according to claim 8, wherein the self-generated video signal output from the video signal generator is a static picture.

10. An HDMI transmitting system for transmitting audio data, comprising:

an audio processor, receiving and processing an audio input signal to generate audio data; and

an HDMI transmitter, receiving the audio data from the audio processor and outputting an HDMI signal, comprising a mode indicator setting a flag if only the audio input signal is available at the input of the HDMI transmitting system, and outputting the HDMI signal comprising only data island periods and control periods if the flag is set.

11. The HDMI transmitting system according to claim 10, wherein the HDMI transmitter transmits the audio data in the data island periods within horizontal blanking or vertical blanking periods.

12. The HDMI transmitting system according to claim 11, wherein the flag extends the horizontal blanking periods by configuring beginning and end points thereof.

13. The HDMI transmitting system according to claim 11, wherein the flag extends the vertical blanking periods by configuring beginning and end points thereof.

14. The HDMI transmitting system according to claim 10, wherein the flag configures preambles transmitted in the control periods indicating a next data period is a data island period for transmitting audio data.

15. The HDMI transmitting system according to claim 10, wherein the HDMI transmitter instructs an HDMI receiver to turn off a display when the flag is set.

16. A system for transmitting audio data using HDMI, comprising:

an audio source, providing an audio input signal;

a transmitter, comprising:

an audio processor, receiving and processing the audio input signal from the audio source to generate audio data;

a mode indicator, reflecting if only the audio input signal is available or both audio and video input signals are available at the input of the HDMI transmitting system;

a video signal generator, generating a self-generated video signal if a video input signal is not available;

a video processor, receiving and processing the video input signal or the self-generated video signal to generate video data according to the mode indicator; and

an HDMI transmitter, receiving the audio and video data from the audio processor and video processor respectively, and outputting an HDMI signal carrying the audio data in data island periods and the video data in video data periods; and

a receiver, receiving the HDMI signal from the transmitter.

17. The system according to claim 16, wherein the self-generated video signal generated by the video signal generator in the transmitter is a static picture.

18. A system for transmitting audio data using a HDMI, comprising:

an audio source, providing an audio input signal;

a transmitter, comprising:

an audio processor, receiving and processing the audio input signal from the audio source to generate audio data; and

an HDMI transmitter, receiving the audio data from the audio processor and outputting an HDMI signal, comprises a mode indicator setting a flag if only the audio input signal is available at the input of the HDMI transmitting system, and outputting the HDMI signal comprising only data island periods and control periods if the flag is set; and

a receiver, receiving the HDMI signal from the transmitter.

19. The system according to claim 18, wherein the transmitter transmits the audio data in data island periods within horizontal blanking or vertical blanking periods.

20. The system according to claim 19, wherein the flag extends the horizontal blanking periods by configuring beginning and end points thereof.

21. The system according to claim 19, wherein the flag extends the vertical blanking periods by configuring beginning and end points thereof.

22. The system according to claim 18, wherein the flag configures preambles transmitted in the control periods indicating a next data period is a data island period.

23. The system according to claim 18, wherein the transmitter instructs the receiver to turn off a display when the flag is set.

* * * * *