

MULTICHANNEL WIRELESS SYSTEM

REFERENCE TO RELATED APPLICATIONS

[001] This application claims the benefit, under 35 U.S.C. 119(e), of the provisional patent application entitled Multichannel Wireless System filed on February 9, 2007 (wherein February 9, 2008 fell on a Saturday) and assigned application number 60/888,961.

BACKGROUND OF THE INVENTION

[002] Multichannel audio systems or sound distribution systems are now commonly referred as home entertainment systems. These systems utilize multichannel audio signals to provide a sound field distribution characteristic of “real life” or concert hall events.

[003] Dolby™ surround sound systems, one brand of multichannel home entertainment systems, utilize separate amplifiers for each sound channel and therefore require a separate audio cable to connect the amplifier to each speaker or sound reproducing device (speaker). The latest Dolby system, designated “7.1,” (seven surround speakers and one subwoofer speaker) includes seven amplifiers, each with an output and correspondingly seven surround speakers situated at different locations within the home entertainment area. Earlier surround sound systems used five or fewer speakers. All such sound systems require two separate electrical conductors to connect the designated amplifier to each speaker.

[004] In a wireless sound distribution system a multichannel amplifier amplifies a composite digital audio signal from an audio source and distributes the audio signal intended for a specific channel (a speaker may be referred to as a channel) to a wireless transmitter dedicated to that audio channel. A wireless receiver located within or proximate an enclosure of the intended speaker

receives the digital audio signal from the associated transmitter. The received signal is then supplied to an audio amplifier for the intended speaker. After amplification the signal is capable of driving the speaker or another sound reproducing device. The channel audio signals are time phased for accurate and realistic sound reproduction at the speaker locations, thereby providing a “real life” sound experience.

[005] Prior art wireless speaker systems suffer from poor audio fidelity, signal drop-out and poor synchronization between audio channels (i.e. objectionable time delays between channels). These effects are due in some cases to the use of the common Bluetooth wireless communications protocol to transmit the signals to each speaker of the home entertainment system. A different communications protocol may be required to avoid these problems. Known solutions may not be feasible for high fidelity surround-sound home theater audio systems due to bandwidth limitations of the selected protocol and hence poor sound fidelity. These system may not be capable of simultaneously handling all sound channels without objectionable time delays between channels.

BRIEF DESCRIPTION OF THE DRAWINGS

[006] The present invention can be more easily understood and the advantages and uses thereof more readily apparent when the following detailed description of the present invention is read in conjunction with the figures wherein:

[007] Figure 1 illustrates elements of a transmit channel of the present invention.

[008] Figure 2 illustrates a transmit channel and a receive channel of the present invention.

[009] Figure 3 illustrates elements of a surround sound system to which the teachings of the present invention can be applied.

[010] In accordance with common practice, the various described device features are not drawn to scale, but are drawn to emphasize specific features

relevant to the invention. Like reference characters denote like elements throughout the figures and text.

DETAILED DESCRIPTION OF THE INVENTION

[011] Before describing in detail the exemplary methods and apparatuses related to a multichannel wireless system, it should be observed that the present invention resides primarily in a novel and non-obvious combination of elements and steps. So as not to obscure the disclosure with details that will be readily apparent to those skilled in the art, certain conventional elements and steps have been presented with lesser detail, while the drawings and the specification describe in greater detail other elements and steps pertinent to understanding the invention.

[012] The following embodiments are not intended to define limits as to the structure or method of the invention, but only to provide exemplary constructions. The embodiments are permissive rather than mandatory and illustrative rather than exhaustive.

[013] In one embodiment a system architecture of the present invention uses a plurality of self-powered transmitters (or transmit modules) that are sufficiently small to be connected directly to a speaker terminal of a master amplifier. Each speaker terminal thus supplies both power and an audio signal to the transmit module. The audio signal (including an audio level) is transmitted in digital format from the transmit module to each speaker. Thus the audio level is reproduced at each speaker with the same audio balance relative to the other speakers as commanded by the master amplifier. Because most communications protocols use high dynamic range digitization, virtually no noise is added to the system by the transmit module or by a receive module associated with each system speaker. A block diagram of one embodiment of a transmit module is shown in Figure 1.

[014] Power for a transmit module 10 (each transmit module associated with an audio channel, wherein each audio channel comprises a speaker) is derived

from a power module 13 comprising an internal power source or energy storage device 14. According to the invention, the energy storage device 14 is refreshed by the audio source power as derived from the audio signal. Alternatively, the power may be derived from a wall plug source with associated wiring to each transmit module 10. This latter alternative is not shown in Figure 1.

[015] The power module 13 for each system channel is powered by the energy storage device 14 (a pseudo-capacitor, an energy storage capacitor, a battery, a capacitor or another energy storage device known in the art) as shown. The signal voltage from speaker terminals 18 represents the audio signal that is split into two components by a signal splitter 22. A first component signal carries a low energy audio signal representing the desired audio content to audio terminals 23 and 24 of the transmit module 10. The audio signal digitally modulates a carrier signal in the transmit module 10 and is transmitted to an associated receiver through one or more antennas 25.

[016] A second component signal comprises a higher energy (low impedance) signal. Within the power module 13, the voltage level of the second component is upconverted by a transformer 26, rectified by a rectifier 30 (a low loss rectifier in one embodiment) and coupled to a charging circuit 34 that maintains a relatively constant voltage to the energy storage device 14 and to a power input terminal 38 of the transmit module 10.

[017] The technique of the present invention powers the transmit module 10 during times of use. Power flow may be interrupted to the power input terminal 38 of the transmit module 10 if the audio level is low or zero for an extended period of time. However, the energy storage device 14 can maintain the power flow to the power input terminal 38 for a short period.

[018] Each receive channel comprises a receiver module 50 that is associated with a specific transmit module 10 as shown in Figure 2. The received signal is received at the antenna 25, processed through the receiver module 50 and supplied as an input to an amplifier 54 for driving a speaker 58. Each receiver

module 50 is a companion to a transmit module 10 for converting the digitally transmitted audio stream to an analog voltage that is supplied as an input to the audio amplifier 54 located within the vicinity of (or within) an enclosure for each system speaker 58. The audio amplifier 54 is of a type known in the art and powers the speaker in a conventional manner. Another embodiment converts the received digital signal to a signal compatible with a digital amplifier used in lieu of the audio amplifier 54. The digital amplifier excites the speaker in a manner known in the art.

[019] Figure 3 illustrates a surround sound system 79 to which the teachings of the present invention can be applied. The system 79 comprises left and right front speakers 80 and 82, a center speaker 83, a subwoofer 84 and left and right rear speakers 86 and 88. Each speaker 80, 82, 83, 84, 86 and 88 is connected to a power source by a conductor 100. A radio frequency controller 110 transmits synchronized radio frequency signals (identified by a reference character 112) to each speaker (channel).

[020] The audio level for each speaker 80, 82, 83, 84, 86 and 88 follows the level presented at the amplifier speaker terminals 18 as encoded in the digitally transmitted source signal.

[021] In one embodiment the system of the present invention utilizes more advanced communications technology and protocols than the Bluetooth standard, operates at a low power than the Bluetooth standard and offers a significant improvement in audio fidelity and channel synchronicity. By operating at a lower power level the system of the present invention enables the presented architecture. The system of the present invention is compatible with any of the existing 5.1 or 6.1 or 7.1 surround sound audio systems and with amplifiers such as those sold by suppliers including Onkyo (of Upper Saddle River, NJ), Denon (of Mahwah, NJ) and Pioneer (of Tokyo, Japan). The user connects a wireless transmitter (transmit module) to each speaker output of the system amplifier and connects a receiver at each corresponding speaker location. Each receiver operates with one or more power amplifiers and the

amplifier(s) connected to an external speaker. Alternatively, the receiver, amplifier and speaker can be integrated into a speaker enclosure a single unit.

[022] The method and elements of the present invention allow consumers to implement surround sound systems and use current technology power amplifiers without the need to install speaker wires from the system amplifier to each speaker. Instead, the consumer purchases each system speaker including a power amplifier to drive the speaker and the accompanying receiver module to receive digital audio signals from the designated transmit module. The present invention provides an easy surround sound system installation in a home theater or other listening location.

[023] While the present invention has been described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalent elements may be substituted for the elements thereof without departing from the scope of the invention. The scope of the present invention further includes any combination of elements from the various embodiments set forth herein. In addition, modifications may be made to adapt a particular situation to the teachings of the present invention without departing from its essential scope. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.