Wireless: It's All Done With Magnetics!

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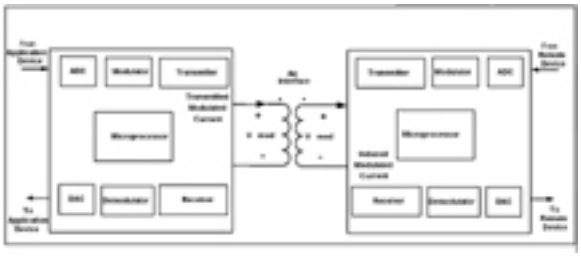
A new alternative wireless technology based on the principles of &quotmagnetic induction&quot has many advantages over other short-range wireless systems &#151 Bluetooth being one example &#151 including reduced size, minimal power consumption, and very low cost.
The first generation of magnetic induction technology, introduced in 1999 by Aura Communications, a fabless semiconductor company based in Wilmington, Mass., targeted voice communications and had several applications including hands-free headsets for cell phones. It consists of two distinct ASICs interfaced with a magnetic antenna array (Figure 1). The antenna magnetically couples signals over a short distance in a power-efficient manner using magnetic fields (an &quotaura&quot). The ASIC circuitry provides a full duplex transmitter and receiver on one chip. Unlike RF systems where many of the transceiver blocks are implemented separately, Aura's chipset completely integrates all essential electronic components to offer the smallest, most cost-effective wireless headset on the market today.



Inductive communication is achieved by means of Reduced Carrier Amplitude Modulation (RC-AM) of the magnetic fields. The voice signal picked up from the microphone in the headset is amplified and modulated by the headset integrated circuit. The output is then used to drive the transmitter antenna with the proper signal to create the RC-AM magnetic field. On the far end of the system, the base unit utilizes a patented tri-axis diversity antenna array, allowing the signal to be received in any orientation. The base unit ASIC receives the signal from the antenna array, demodulates it, and converts it back to baseband voice. Full-duplex voice transmission occurs when essentially the same process is performed in reverse.
The magnetic approach has clear advantages over RF and infrared (IR) technologies. RF consumes more power, adding size and weight to products like headsets. In addition, RF transmits several tens of meters, so it requires encryption to avoid eavesdropping and channel selection to avoid interference with other users. Wireless magnetic-induction technology, on the other hand, is designed to work within a sphere of 1.5 meters of the user. Due to the close proximity of this &quotpersonal area network,&quot security and interference issues are minimized. Infrared requires line-of-sight between the transmitter and receiver. This is impractical in a wireless headset product, where the head is in constant motion. Magnetic induction-based systems require no line-of-sight and the head can move unrestrained.
The cost of the overall system is low due to the highly integrated ASIC. Unlike

traditional systems, which require a front-end radio chip, T/R switch and baseband processor, the Aura ASIC performs all these functions. Also, the magnetic transmission operates at a lower frequency, which in turns allows the use of more mature and cost effective processing and packaging.

This technology's throughput, power consumption and footprint has been steadily improved, resulting in a programmable single-chip device for wireless communications, allowing point-to-point, and point-to-multipoint voice and data transmission. The Aura &quotLibertyLink&quot SOC offers high-quality 64v Kbps CVSD voice and data transmission at data rates of 204.8 Kbps for point-to-point, and 51.2 Kbps for point-to-multipoint systems utilizing one master and four slaves. All the while, the system draws less than 7mA current for 1-meter applications.

This IC achieves the high throughput required for data by passing a Gaussian Minimum Shift Keyed (GMSK) magnetic field between the base and remote units. The same chip is used in both the base and remote implementations, with only minor circuit and firmware changes. Likewise, the versatile microprocessor firmware can be programmed to suit many vertical applications, including cell phone headsets, game controllers, and the wireless desktop.

For flexibility and ease of manufacturing, the new SOCs are software programmable to fit a variety of applications, including voice, data transfer from point-to-point, and data transfer from point-to-multipoint. Application Programmable Interfaces (APIs) allow OEMs to define particular functions to differentiate their products. The system firmware is included with the ASIC.

A typical point-to-point application is a connection between two devices, like a wireless mouse to a computer. A point-to-multipoint involves one master and up to four slave devices, like a wireless desktop that contains a wireless keyboard, mouse and headset, all talking simultaneously to the computer (Figure 2).

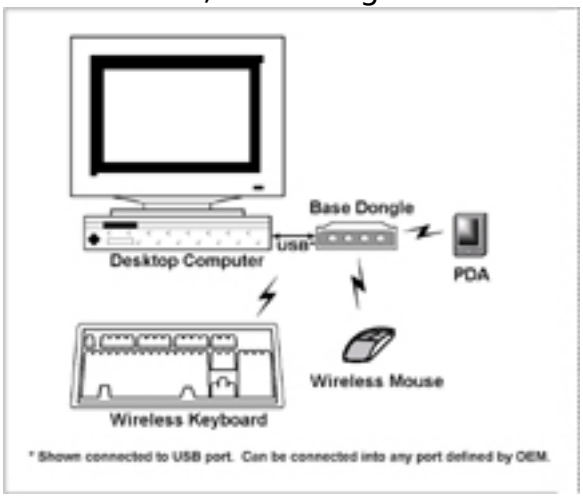


Figure 2: Wireless Keyboard, Mouse & PDA Sync

Several practical examples of high-performance products that can be realized immediately by integrating a magnetic induction-based SOC and firmware include:

Wireless Headset

The wireless headset can be used to transmit voice over a wireless link for connection to a mobile phone, desktop computer, PDA audio, Internet device, or voice navigation device. In this model, voice is the primary media and data transfer is minimal. With the majority of the bandwidth dedicated to voice, high-quality 64 Kbps CVSD encoded and randomized voice data can be transmitted and received. In

the full audio configuration of the headset, small packets of data can also be transmitted.

The Wireless Keyboard/Mouse/Joystick

These ICs can deliver data across a wireless link, enabling devices like wireless keyboards, mice, and game controllers. With the ability to send data from point to multipoint, a wireless desktop is possible. Using a base unit &quotdongle&quot that plugs into the USB port (or other applicable port) of the computer, a wireless keyboard, mouse, and joystick can be used simultaneously. In a typical design, four frames with nine slots per frame and 816 bits per slot are used, and an effective data rate of 51K bps per device is achieved. Each bit is 4.88 &#956s in duration. This is well above the current data rates necessary for a keyboard, mouse, or game controller.

The Wireless Game Controller

Using the same timing model for a wireless keyboard and mouse, up to four wireless game controllers can be configured for concurrent use. The base unit uses one chip with the output separated out into four lines. Each line will plug directly into one of the input ports of the game console. Each of the four game controllers is battery operated, useable within 3 meters of the base console, and can achieve data rates of 51.2 Kbps.

The Wireless Data Device

In addition to keyboards, mice, game controllers, and PDAs, magnetic induction wireless technology can be used to add connectivity to any device that requires medium data rate transfer in close proximity. Most commercial devices use only a single input device, but up to four can be added. These devices would include point-of-sale terminals, bar-code scanners, keyless remote entry devices, home security systems, and monitoring systems to name a few.

The Wireless PDA Hot-Sync

Wireless PDA synchronization is greatly simplified using this technology. With the ability to seamlessly transfer 204.8Kbps data across the link, the IrDA port of the PDA can be eliminated. Line of sight is no longer required and the circuit can be embedded anywhere in the device. Using a base unit dongle connected into the USB port, the PDA can sync within 2 meters of the dongle. This device can also be used with the wireless headset for audio application through the PDA.

In addition to these uses, the product roadmaps of many leading market analysts highlight several categories that can benefit from low-cost and low-power wireless technology. Aura has been exploring ideas for PDA synchronization and voice channels, voice recognition including telematics, wireless Internet terminals, point-to-point data transfer, wireless headsets for office phones, wireless multimedia, and wireless headphones for computers. The following lists some examples of potential uses of Aura's wireless technology.

&#149PDAs with voice capability are expected to become mainstream over the next few years. Usage models show that users will need to look at the screen and talk concurrently. This will require a headset of some type. Aura envisions a wireless headset that slides into the PDA, like a stylus. While docked, this headset transceiver could also be used to synchronize with a desktop.

&#149In desktop computing, mobile communications, telematics and several other applications, voice recognition is taking over as the input media. One key requirement of voice recognition is noise-limited voice inputs. As a result, a

microphone located at the mouth is more effective than a microphone located several feet away. In other words, voice recognition will require a headset microphone rather than one located in the dashboard or embedded in a laptop or PDA.
&#149For wireless Internet appliances, much like the PDA, there is a desire to have a two-way audio link. This link can be used to voice navigate in one direction, or listen to multimedia in the other direction. The wireless headset would attach to the device in this application.

&#149Point-to-multipoint data devices rely on data channel and time-multiplexing technologies to enable applications such as wireless keyboards, mice, PDAs, joysticks, headset communication to a computer, and multiple game controllers communicating to a video game console.

The technology advantages of magnetic induction for short-haul, personal-area wireless networking becomes clear as one begins to add up the use and implementation advantages. This is the only technology that significantly cuts power consumption in portable devices today (by 10-30X). Add to this the reduced system cost and multipoint capability, and it becomes clear that this is a design approach that will win broad acceptance in a variety of applications in short order.

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