Audio Processor Series for Mobile Phones

OKADA Kengo

Abstract

The Audio Processor series is an audio companion LSI chip to playback long-hour audio data on mobile phones. It employs a configuration that can be easily added to the conventional system of mobile phone set.

AP130, one of the models of the AP series, employs the "SD Audio" function that enables music data to be downloaded and played without copyright infringement. It is not necessary to have the application processor operate. This feature allows manufacturers to reduce both the time to market and the cost, and 50 hours of continuous music are enabled to be played back.

Keywords

companion LSI, mobile phone, audio player, long-hours playback, copyright protection, 90nm process

1. Introduction

Portable audio players are widely spread on the market these days and various services that feature music distribution and related technologies have also been enhanced. Audio data extracted from CDs or downloaded from the Internet are now available to listen to anytime and anywhere. People are now beginning to welcome digital audio as a familiar technology.

This trend is accelerating the demand to mount audio player functions on mobile phones. More mobile phone carriers have started music distribution services so that mobile phones equipped with audio player functions are now available all over the world.

High performance digital base-band LSIs and dedicated application processors can perform audio player functions. However, because of their high performance characteristics, they require a large consumption of power, which prevents long-hours continuous playback of music. NEC Electronics has now developed an audio companion LSI chip to enable long-hours music playback on mobile phones without consuming a large amount of power.

2. Concepts of the Audio Processor Series

The Audio Processor series focuses on the following concepts.

- Long-hours playback
- Dedicated to a mobile phone system
- Compatibility with conventional systems (easy add-on capability to any platform)
- Copyright protection capability

The Audio Processor series employs the following technologies in order to enable the above concepts.

- 90nm process
- Compact BGA package with the size of 6mm × 6mm
- Compact low power consumption CPU/DSP core processors dedicated to audio data processing

The development background of the Audio Processor series and one of the series products, AP130 (a photo of which is shown below) are explained in the following sections.

3. Long-Hours Playback

"Long-hours playback" is the essential theme for the Audio Processor series.

Most of the present mobile phones with an audio player function are able to playback audio data only for several hours continuously. This seems to be long enough for music playback when assuming the situation that a user listens to music with a mobile phone when commuting to school or office etc., and sets it by a battery charger or a cradle at home. However, the most important function of a mobile phone is "talking" on a phone. Enough power always has to be maintained to support talk and standby time.

For a user listens to music with a mobile phone for five hours a day, if he/she plays back music five hours continuously, there will not be enough power left for talk and standby time. This means that a user must always be concerned about battery shortage while listening to music, or sometimes about hours to

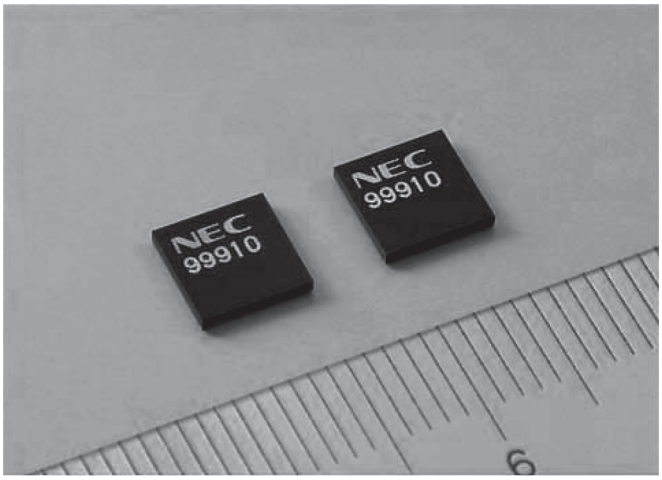


Photo AP130 (μPD99910).

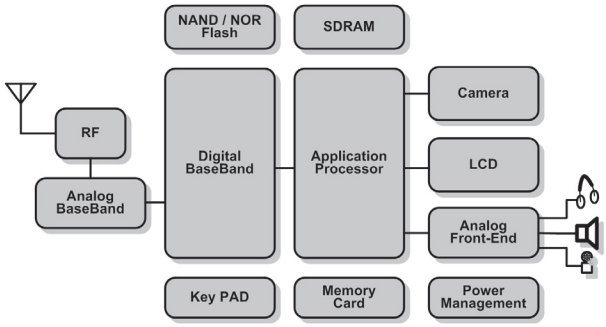


Fig. 1 Outline of the system configuration of a mobile phone.

talk and even standby time. Such a situation will affect the enjoyment of music. By employing the AP130 processor (**Photo**), a mobile phone maintains a power of 50-hours continuous playback which is tenfold the conventional playback hours, power consumption to playback music will be approximately 10% of the battery capacity of a mobile phone. The balance of 90% battery life can be maintained for talk and standby time and other functions so that a user can enjoy music without being concerned about battery life shortage.

As explained above, long-hours playback ability which is available with a portable audio player is an essential function to support mobile phones as well as enabling a user to enjoy music anywhere and at anytime.

3.1 System Configuration in Presently Main Stream

The system configuration of a mobile phone is composed of various kinds of parts as shown in **Fig. 1**. Among these, an LSI called an application processor deals with application functions other than the telecommunications and talk functions. These are the camera functions, image processing, movie processing and music data processing, etc. With some mobile phones, a digital base-band LSI processes these functions and processing. The application processor mounts high performance and high speed CPUs and DSPs to enable these various functions.

A countermeasure to lower the power consumption has already been applied to the application processor. However, it was designed to process applications requiring a huge amount of calculations such as the camera function, image processing and movie processing. A consequence of this, a large size circuit is needed as well as a high operation frequency, which consumes a large amount of power. The result is that the music data can be played back for only several hours. However, such a high speed processing circuit is not required for audio processing.

3.2 Increasing the Playback Hours

Increasing the playback hours is equivalent to decreasing the power consumption. The following three measures are considered essential to increase the playback hours.

1) Employing a battery with a high current capacity
2) Decreasing the power consumption of each of the parts
3) Operating the essential parts only

Countermeasure 1) is the easiest way to compensate for a shortage of current capacity. However, downsizing is considered to be the most critical function for a mobile phone. A battery with a high current capacity consequently requires a large physical size, so that it may be rejected as a suitable mobile phone component.

Countermeasure 2) has been already individually promoted at the parts manufacturing sites. However, power consumption and parts performance is a trade-off relationship. The more the performance is increased, the more power is consumed. Countermeasure 2) thus results in limiting the playback hours. The length of playback hours is determined by the current capacity of the battery and the total amount of the power consumption of the mobile phone. As explained in countermeasure 1), the current capacity of the battery is assumed to maintain the present condition. In such a condition, it is essential to decrease the total power consumption of the mobile phone. However, as explained in countermeasure 2), there is a limit to the possible decrease in the power consumption of each part. In consider-

ing these issues the countermeasure 3) seems to be the most realistic solution. It is possible to prevent operation of unnecessary parts while operating a target application.

3.3 Standalone Playback

When using a mobile phone as a portable audio player, most users listen to music by playing back audio data stored in a memory card. Also, they do not necessarily look at the LCD screen of the mobile phone, except when operating certain functions. The functions processed to playback music are;

- Readout audio data from a memory card
- Data processing (decryption, coding/decoding, effect processing)
- Data transmission
- DAC (Digital to Analog Converter)
- Driving head phone operation
- Supplying power

AP130 is located as shown in **Fig. 2**, and performs a series of operations by itself; reading out data files from a memory card and sending it to the DAC (Digital to Analog Converter).

The CPU in the AP130 reads out a file from an SD card (**Fig. 3**). The read out data is processed in order to unlock the DRM (Digital Right Management) and then sent to the built-in DSP (Digital Signal Processor) to be decoded by a firmware audio decoder. The generated PCM data is then output to a DAC via an audio serial interface.

The AP130 performs processing in such a manner, so that its playback activity may be regarded as a standalone function. During standalone playback, many of the parts mounted on a mobile phone set, including the application processor like that shown in Fig. 3 can be powered OFF, except when inputting control commands such as for Play or Stop. This measure significantly reduces the power consumption and enables 50 hours* of continuous music playback.

*The playback figure is based on in-house setup data conditions.

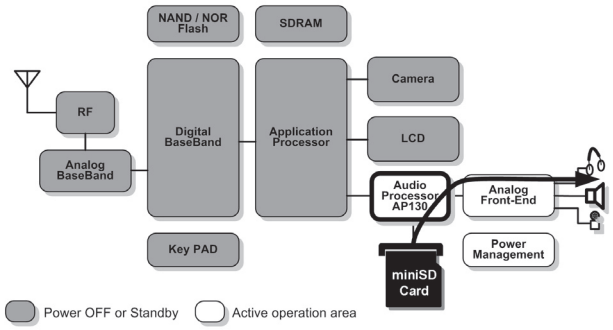


Fig.2 Signal path in the AP130 during standalone playback.

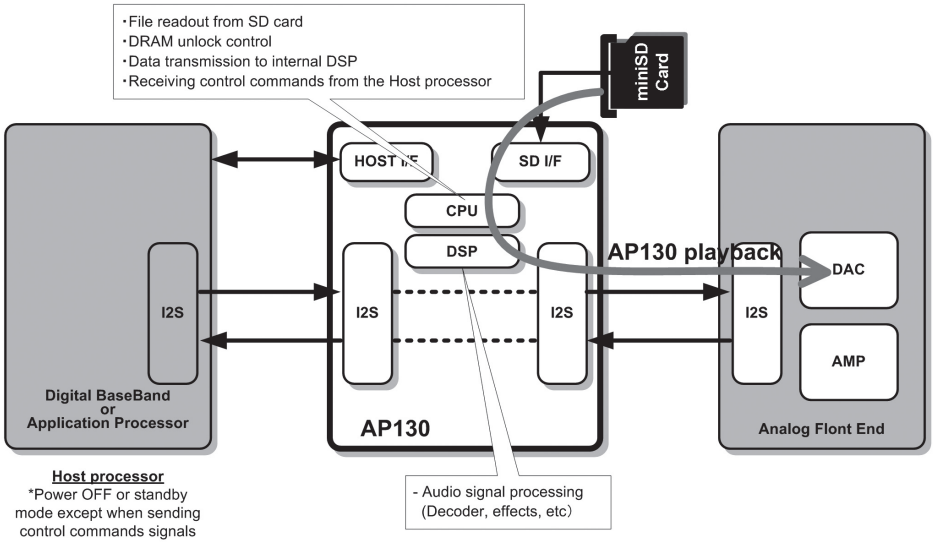


Fig. 3 Signal path and main parts operation conditions during standalone playback.

4. Specializing in a Mobile Phone System

Many of the audio processors for portable audio players are already available on the market. The following measures are applied when these audio processors are adopted for mobile phones.

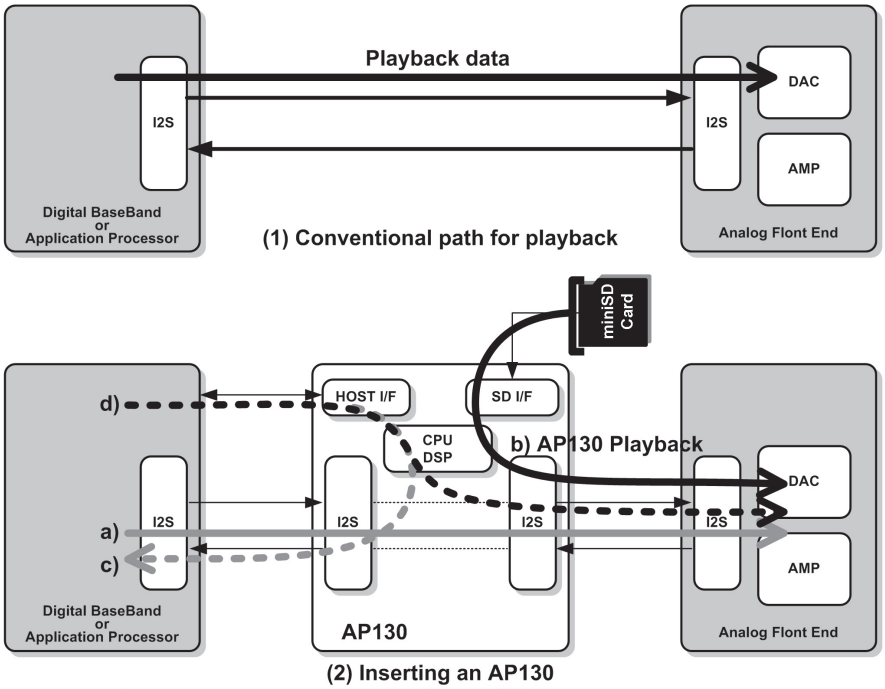
A mobile phone already mounts various devices; digital base-band LSI, application processors, LCD driver, power control LSI, etc. for booting the LSI power supply, LCD screen control and user operating functions such as “Play,” “Stop” and “Pause.” This means that various functions of the mobile phone and portable audio player are overlapped and are the cause of disadvantages price wise and also space wise with regard to mounting when a duplicate processor for a portable audio player is also mounted on a mobile phone.

AP130 eliminates these overlapped functions as much as possible. This resulted in compact package size and improvement of low power consumption.

4.1 Dedicated Compact CPU and the Background of DSP Development

The CPU and DSP employed for the AP130 are dedicated to audio signal processing.

The circuit is basically written by C language. Therefore, it is made easy to build circuits dedicated to conventional high-performance macro and audio functions. A behavioral synthesizer, Cyber enables decreasing the circuit size by optimizing functions such as the common use of calculations at the upper layer operations level. Moreover, in order to realize low power consumption, commands and factors, which are frequently operated and contain a large number of operations, are detected for mounting onto the hardware as a dedicated co-processor. This enables a highly compressed decoder processing function, which requires a high-speed processing capability at a



a) Conventional playback path
b) Playback path from an SD Card
c) Linkage path with the Host processor
d) Audio file playback path stored other than on a SD card

Fig. 4 The signal path when an AP130 is mounted.

comparatively low frequency.

5. Compatibility with Conventional Systems

High performance functions of the mobile phone have recently been accelerating, so that the development processes are becoming more and more complicated. NEC Electronics considers that the manageability of designing LSIs for mobile phone sets and the development of new models are vital issues for the mobile phone manufacturers. Therefore, we have tended to focus on development in these areas, so that our AP130 can be added onto conventional set systems (including old models) in order to encourage innovative development by mobile phone sets manufacturers as much as possible.

(1) Employing a Parallel Interface

A widely marketed SRAM interface is employed as the host interface to control the AP130 by its application processor and the digital base-band LSI (hereinafter referred to as the host processor).

(2) Employment of Two of Audio Serial Interface Ports

Two audio serial interface ports that are compliant with the I2S standard are employed. The system that is shown in **Fig. 4(a)** sends a signal to the DAC from the host processor via the audio serial interface. With such a system, it is possible to allocate the AP130 by inserting it on the signal path as shown in **Fig. 4(b)**. When no processing is necessary on the AP130 (indicated by the red-color path in Fig. 4), the data signal passes through it. At such times, most of power of the AP130 is OFF internally and operation in the low power consumption mode is available. Moreover, both of the interfaces mount I/O devices so that the AP130 can be used as an external calculation function for the host processor.

(3) API Provision and the Various Required Software

The various required functional software such as the decoder, etc. are provided as dedicated firmware. Sample sources and APIs for control device drives are available so that our clients can easily carry out the mounting and decrease the development process of the application software.

6. Countermeasures for Copyright Protection

The AP130 mounts a CPRM function that is compatible with the SD standard DRM. CPRM or Content Protection for Recordable Media is a licensed copyright protection technology co-developed by Intel, IBM, Panasonic and Toshiba. This technology enables easy configuration of the SD Audio function with a copyright protection capability. To deal with DRMs other than CPRM, playback music can be made available by unlocking the DRM with a host processor and sending the streaming data to the AP130 (indicated by a green arrow in Fig. 4(b)).

7. Marketing the Audio Processor Series

The Audio Processor series will be marketed as several models that will be categorized by their different mounting functions, such as compatibility with different DRMs and decoders, etc. A digital amplifier is scheduled to be mounted in order to increase the playback hours. The AP130 has already been mass produced and marketed under the model name of μPD99910.

8. Conclusion

NEC Electronics plans to continue to develop a variety of customer oriented products that feature low power consumption characteristics, as well as products that satisfy the demand for mobile phone audio players.

Authors' Profiles

OKADA Kengo
Assistant Manager,
Mobile LSI Division,
3rd Systems Operations Unit,
NEC Electronics Corporation

●The details about this paper can be seen at the following.
Related URL: http://www.necel.com/ja/channel/vol _0060/vol_0060_1.html