SCOMBO/UM: World's First* Optical Drive System LSI to Support Recording/Playback of Both Next-Generation DVD Formats, HD DVD and BD

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Abstract

2006 became the first year in which players compatible with HD DVD or BD (Blu-ray Disc), the next-generation DVD formats, were introduced into the market respectively. This coincides with the spread of large-screen high-definition TVs and the start of digital HD broadcasts, thereby boosting expectations for next-generation DVD.

NEC Electronics has succeeded in the development and commercialization of the SCOMBO/UM recording/playback drive system LSI that supports both HD DVD and BD as well as current DVD and CD standards, making it the world's first to offer compatibility with all of these media. This paper introduces this breakthrough.

Keywords

HD DVD, BD (Blu-ray Disc), optical disc drive, SCOMBO, digital read channel, AACS certification

1. Introduction

Due to the spread of large-screen high-definition TVs and the start of digital HD broadcasts, Hi-Vision is becoming more and more common in ordinary households. As a result, expectations are growing for a next-generation DVD that enables the distribution, archiving and exchange of large amounts of data. It is also true, however, that current DVD and CD offer a superior storage-to-cost ratio, and are thought to offer continued potential as important optical disc media that have recorders/players spread throughout the world.

NEC Electronics has taken such market trends into consideration, and developed the world's first optical drive system LSI to enable recording/playback of both next-generation DVD formats (HD DVD and Blu-ray Disc), the SCOMBO/UM. This system LSI (see **Photo**) is comprised of the µPC3360 which handles analog processing and µPD63410 which handles digital signal processing, and is capable of recording and playing not only next-generation DVD format discs but also current CD and DVDs.

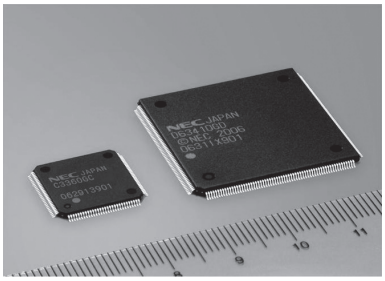

Photo External view of µPC3360, µPD63410.

*As of October 2006

2. The 2 Next-Generation DVD Formats

2.1 HD DVD and BD

Among the next-generation DVD formats, HD DVD is the one established by the DVD Forum, and BD is the other established by the Blu-ray Disc Association. Both next-generation formats use a blue laser diode for the optical pickup unit that reads/writes data, making it possible to attain 3 to 5 times the capacity of current DVD.

Since HD DVD shares the same disc structure as current DVD, it is possible to minimize disc manufacturing costs. By contrast, although BD's structure differs from that of current DVD, its main feature is that it offers higher capacity than HD DVD (**Table**).

Table Comparison of next-generation DVD formats.

	HD DVD	Blu-ray Disc	Current DVD
Capacity of playback disc (single layer)	15GB	25GB	4.7GB
Laser wavelength	405nm	405nm	650nm
N/A	0.65	0.85	0.6
Thickness of protective layer	0.6mm	0.1mm	0.6mm
Transfer speed	36Mbps	36Mbps	11Mbps
Encoding method	ETM	17PP	EFMplus

2.2 Involvement in Next-Generation DVD Formats

Our involvement in next-generation DVD formats includes the development and commercialization of the world's first system LSI for HD DVD, the SCOMBO/HD (part number: µPD63400). Through development of the SCOMBO/HD, we were able to establish the core technology required for next-generation DVD. And this year we successfully developed the SCOMBO/UM system LSI that supports recording/playback of various optical discs including the two next-generation DVD formats HD DVD and BD as well as current DVD and CD.

2.3 Product Development from Now Onward

In the past, NEC has developed and evolved the SCOMBO Series of system LSI for recording/playback of DVD/CD.

The SCOMBO/UM is a new series that supports next-generation DVD recording/playback based on the DVD/CD recording/playback function of SCOMBO. Along with future market expansion we will promote the increase in performance to further product evolution (**Fig. 1**)

3. Functions and Characteristics of SCOMBO/UM

3.1 Product Overview

Here we will explain regarding the overview of the two system LSIs that comprise SCOMBO/UM (**Fig. 2**).

µPD63410 integrates a digital servo, data processors and decoder/encoders that support each format, NEC's 32bit CPU V850 core, and parallel/serial ATA host interface into a single chip.

µPC3360 integrates the RF signal processing circuit, sample hold circuit, focus error/tracking error detection circuit, mirror/radial contrast/defect detection circuit, wobble detection circuit, auto laser power control circuit, and others, into a single chip.

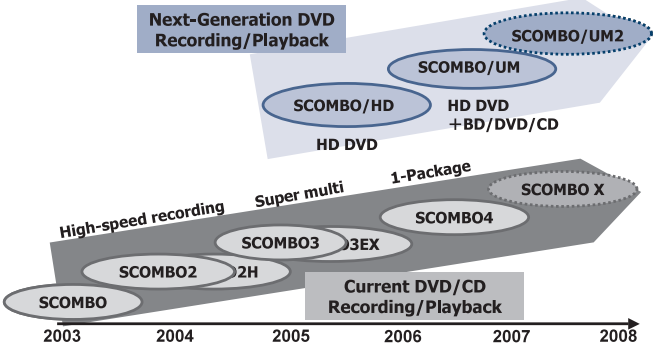

Fig. 1 SCOMBO Series evolution.

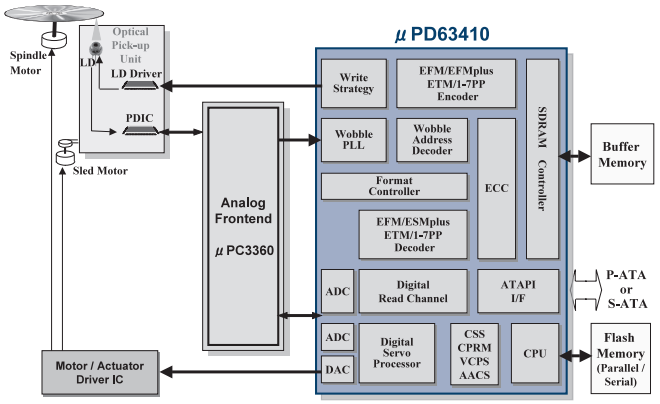

Fig. 2 System architecture overview.

These two system LSIs are capable of recording/playing HD DVD and BD at 5X speed, so by equipping them in next-generation DVD compatible playback drives, players and recording/playback drives, and recorder units, it will be possible to create equipment offering the highest performance standards.

3.2 Characteristics of µPD63410

Here we will explain about the main characteristics of µPD63410.

µPD63410 is equipped with a high-speed digital read channel that allows 5X speed for HD DVD/BD, 16X speed for DVD, and 48X speed for CD, using technology that is an accelerated version of the digital read channel NEC newly developed for SCOMBO/HD (refer to Chapter 3, Section 4).

Moreover, it supports the next-generation DVD copyright protection technology AACS (Advanced Access Content System), and features integrated hardware to enable AACS authentication at high speed, as well as our original support technology to raise the security performance of drive equipment (refer to Chapter 3, Section 5).

For BD recording/playback, we also developed a new 1-7PP modulator/demodulator circuit, ADIP decoder, high-speed ECC encoder specifically for BD, and error correction processing method. And by borrowing numerous circuits from our SCOMBO DVD recording/playback system LSI, including Servo control and Write Strategy control, we were able to attain a high degree of operational compatibility with SCOMBO, thereby making it possible to port or borrow from SCOMBO

solution firmware.

In addition, µPD63410 offers the following features:

1) Write Strategy: Resolution: 1/32T, LVDS output supported

2) Supports both parallel/serial ATA

3) External buffer memory

16M/64M/128M bit SDRAM support

4) Flash ROM I/F for integrated CPU

Parallel/serial Flash memory selectable

5) Power supply voltage: 3.3V for I/O section, 1.5V internally

6) CMOS 0.15µm process

7) Package

2 types of packaging to support Slim drive

・256pinLQFP (28 × 28mm)

・281pinFPBGA (17 × 17mm)

3.3 Characteristics of µPC3360

Here we will explain about the main characteristics of µPC3360.

µPC3360 was developed based on the µPC3345 analog signal processing LSI for SCOMBO3EX, one of the SCOMBO Series. As a result, its basic architecture and performance are equivalent to µPC3345, and as the case is with µPD63410, it achieves a high degree of compatibility and affinity with the SCOMBO Series.

In addition, it also uses a 2 channel RF signal differential input interface and other technologies to interface with the optical pickup that is compatible with current DVD/CD as well as next-generation HD DVD and BD. µPC3360 also offers the following features.

1) RF Signal Processing

・Integrated RF signal processing and equalizer, Single end/differential output

・AGC function built-in

2) Servo System Processing

・Integrated sample hold matrix circuit

・Integrated Servo AGC circuit

・Gain, balance, offset alignment functions built-in

・Focus error detection

Differential astigmatism method, FO+/FO-2 input method supported

・Tracking error detection

DPD, DPP, 3-beam signal element method supported

3) Power Supply Voltage: 5V single power supply

4) BiCMOS 0.35µm process

5) Package

・120 pin TQFP (14 × 14mm)

3.4 Digital Read Channel

The Digital Read Channel detects data strings from the read signals found in the mark rows recorded on the disc using full-digital technology. As shown in **Fig. 3**, it is comprised mainly of 6 blocks; the offset canceller, digital AGC, asymmetry canceller, digital PLL, adaptive equalizer, and Viterbi detector. The following are the main functions of each block.

(1) Offset Canceller

After the analog read signal from the µPC3360 is converted into a digital signal by the A/D converter, low frequency noise and the offset that occurs due to asymmetry (asymmetric properties of the playback signal's amplitude) are eliminated by this function. As a result, it is possible to raise the detection performance of the Viterbi detector.

(2) Digital AGC

The offset-corrected digital signal is adjusted by this function so that its amplitude value becomes constant. As a result, it is possible to accelerate the tap coefficient convergence of the adaptive equalizer.

(3) Asymmetry Canceller

Nonlinear components contained in the gain-adjusted digital signal's read signal are then eliminated by this function. Since the adaptive equalizer is a linear filter, it is unable to compress nonlinear components. By raising nonlinearity beforehand through this function, it is possible to raise the detection performance of the Viterbi detector.

(4) Digital PLL

This generates the timing that is synchronized with the playback channel, from the asymmetry-corrected digital signal. Coordination with the Wobble PLL enables the recorded area following a non-recorded portion to be played from the beginning. Furthermore, a frame synchronization detection function that supports various ROM media is built-in, making rapid pull-in possible.

(5) Adaptive Equalizer

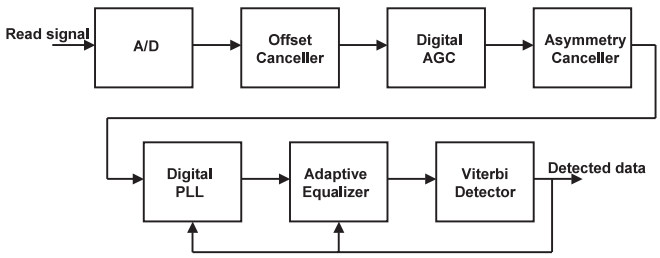

Fig. 3 Digital Read Channel block architecture overview.

The asymmetry-corrected, channel-synchronized digital signal is equalized by the PR channel as specified by the 7 tap FIR filter. The PR channel is equipped with a number of effective methods including PR(12221) and PR(1221). Each tap coefficient is adaptively controlled so that the equalization error approaches 0.

(6) Viterbi Detector

The digital signal that was equalized by the PR channel using adaptive equalization is then converted utilizing the two surest estimated values of data arrived at by this function. To generate these values this function uses the minimum run length limit of the encoding as well as characteristics of the PR channel.

3.5 Security Functions

µPD63410 supports content protection functions as well as tamper-prevention functions. For content protection, past developments include CSS for DVD-ROM, CPRM for DVD-RW, and VCPS for DVD+RW, and as the function to protect HD content there is the AACS authentication function. Although AACS authentication includes specialized parts that were established separately for HD DVD and BD, µPD63410 supports both. The tamper-prevention function detects whether a program located in external memory has been hacked or not. If it detects that the data within the external memory has been hacked, it takes defensive measures such as shutting down the program to prevent illegal operations. Main features are as follows:

(1) AACS Authentication Function

AACS is a copyright protection technology that controls the usage of content stored on a next-generation optical disc. Among the AACS related technology, the LSI includes the following technologies that are necessary for AACS certification.

- SHA (Secure Hashing Algorithm) Hashing Function
- CMAC (Cipher-based Message Authentication Code)
- AES (Advanced Encryption Standard)
- ECDSA (Elliptic Curve-based Digital Signature Algorithm)

(2) Tamper-Prevention Function

Since the V850 equipped in µPD63410 operates in accordance with the content stored in flash memory, it is necessary to prevent the running of hacked programs from the standpoint of content copy protection. For this reason, µPD63410 checks the content of the flash memory, and codes are run only in cases where it is determined that the content has not been hacked.

4. Conclusion

From CD-ROM drive LSI to DVD recorder drive LSI, NEC Electronics has always developed system LSI to meet the needs of the market and of end users. As was the case with CD and DVD, faster writing/reading speeds and further system integration seem inevitable for next-generation DVD formats as well.

At NEC, we strive to be the first to achieve these elemental technologies, enabling us to develop products that meet the needs of users. What's more, we intend to prepare solution kits such as an evaluation board and drive control firmware, so that drive manufacturers can shorten their product development cycles.

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