FEATURING

Optical Pickup Device that Achieves 8×-Speed Blu-ray Recording and Playback

The Industry's Highest Level of Low-Noise and High-Speed Performance Breaking the Technological Barriers to 8×-Speed Blu-ray Recording and Playback

RF/Servo (PDIC)

- Built-in wideband (230 MHz) I-V amplifier
- Low noise (-4.4 dB at 176 MHz compared to current products)
- Multi-stage gain switching (IV: 8 stages)
- High-sensitivity photodetector (0.3 A/W at 405 nm)

Power Monitor (PDIC)

- Rapid settling: 6 ns (Typ.)
- Wide-range gain adjustment function (differential gain: 0.24 to 44.4 V/mW)
- Built-in sample-and-hold circuit
- Serial interface

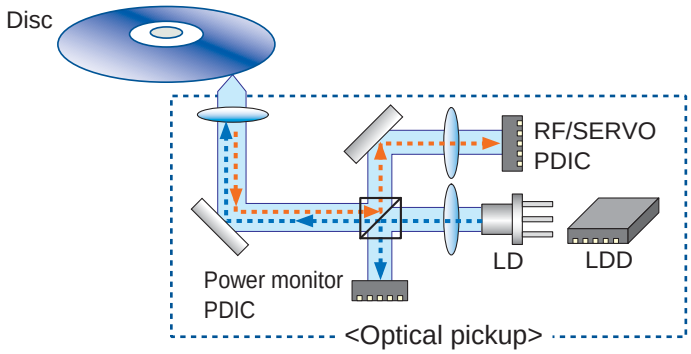
Laser Diode Driver (LDD)

- Operating frequency: 16 to 530 MHz
- Minimum 59 ps (1/32T) resolution
- Built-in write strategy
- Sampling pulse output for external sample-and-hold function
- Maximum drive current BD: 550 mA, CD/DVD: 1000 mA

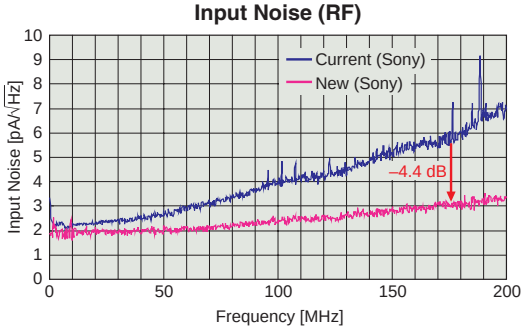
Blu-ray Discs are used in a wide range of products including recorders, PCs, and games, and the popularity of this technology is expected to increase rapidly. To realize the potential of the Blu-ray Disc even further, Sony is continuing development efforts aimed at achieving recording and playback at Blu-ray Disc speeds of 8× and higher and at achieving even higher recording capacities through even higher layer counts in multilayer Blu-ray Disc media. Improving the performance of the optical pickup (OP) is critical to achieving these goals and in particular, the photodetector IC (PDIC) and laser diode driver (LDD) mounted in the OP hold the key to these improvements. To achieve 8× Blu-ray Disc recording and playback, two or more times the bandwidth of existing 16× DVD recording and playback OPs and even lower noise are required. This is extremely difficult for current device and circuit technologies. To resolve these Blu-ray Disc issues, Sony has developed a new BiCMOS process for PDICs and has achieved both low noise and fast response times. By increasing the compatibility with the PDIC while at the same time increasing the performance of the LDD as well, Sony has proposed a new architecture for 8×-speed Blu-ray Disc recording and playback.

Devices Mounted in the OP

In general, both an LDD that drives the laser and PDICs, which are photodetector ICs, are mounted in the OP. There are two PDICs: an RF/servo signal detection PDIC that converts the light reflected from the disc to an electrical signal and a power monitor PDIC that monitors the laser power. (See figure 1.) The RF/servo PDIC has the roles of detecting both control signals, such as the OP focus signal and the tracking signal, and the playback data signal from the light reflected from the disc. The power monitor PDIC is a device that functions as the metric for the



■ Figure 1 Optical Pickup Structure Overview



■ Figure 2 Noise Characteristics Comparison

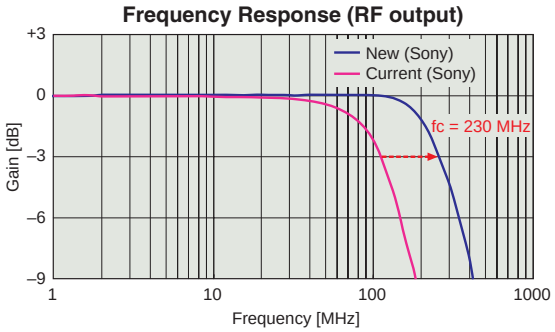
laser automatic power control (APC) system. This device directly monitors the laser output and monitors the laser power during reading and writing.

PDIC - RF/Servo

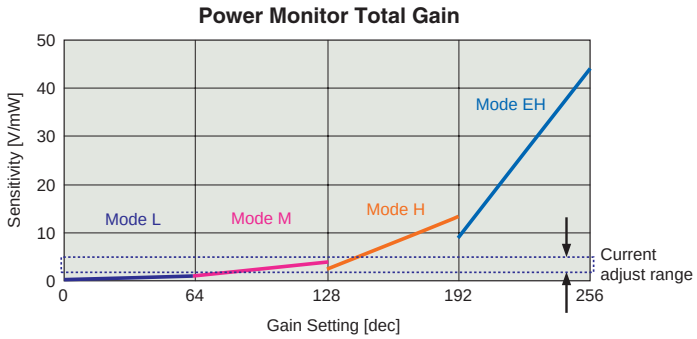
Extremely fast response and gain settings that support the recording and playback levels for a variety of media are required to achieve practical 8×-speed Blu-ray Disc recording and playback. Also, as the speed multiple increases, the PDIC becomes the main contributing factor to noise in the playback signal. Therefore the designers cannot simply aim to increase the bandwidth, they must also achieve lower noise. In the RF/servo PDIC developed in this effort using a new process, Sony (a) reduced the parasitic capacitance by using finer fabrication, (b) used high-precision capacitors, and (c) took full advantage of new circuit technologies to achieve a multi-stage (8-stage) gain switching in the transimpedance amplifier and at the same time reduce the noise by a significant -4.4 dB (as compared to current Sony products). (See figure 2.) Also, to make it possible to achieve 8×-speed Blu-ray Disc recording and playback, Sony achieved the wide bandwidth of fc = 230 MHz, which is approximately twice that of current products. (See figure 3.) This performance is fully adequate to handle the fastest signals that occur in 8×-speed Blu-ray Disc playback (the 2T iteration × 8 = 132 MHz).

PDIC - Power Monitor

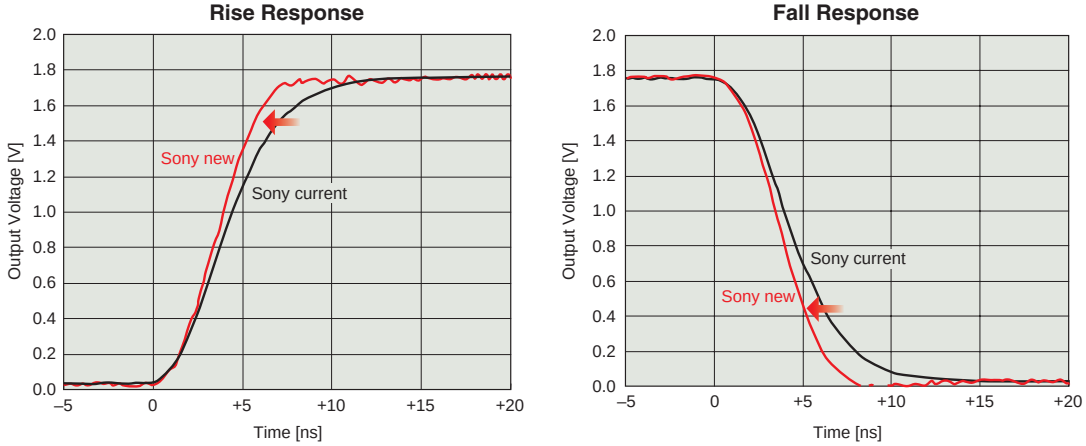
Improving the response speed of the power monitor PDIC is required to achieve 8×-speed Blu-ray Disc recording. When reading out data during playback, the laser operates in a DC optical generation mode, and it is not necessary for the power monitor to respond quickly. However, when writing data to a disc, the laser operates in a pulse optical generation mode, and rapidly changing signals are input. The APC system during recording samples both the mark level when writing data to the disc and the space level when not writing data, and this operation is established by correct monitoring of the laser output. The longest mark or space period in 8×-speed Blu-ray Disc recording is 15.15 ns, and the power monitor output signal must settle within this period. The power monitor PDIC developed using a new process during this effort achieves both a wide range gain adjustment function (see figure 4) and the high-speed settling performance (8 ns, Typ.) required for 8×-speed Blu-ray Disc recording while transmitting over a flexible



■ Figure 3 Frequency Characteristics Comparison



■ Figure 4 Gain Adjustment Range



■ Figure 5 Power Monitor Response Waveforms

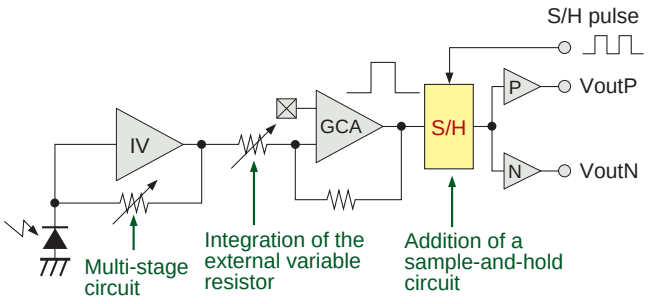
PC board. (See figure 5.) We also reduced the number of external components in the OP by moving the external resistor conventionally required for gain adjustment into the IC.

Sony has additionally proposed integrating the sample-and-hold circuit in the power monitor. (See figure 6.) In the conventional approach, reduced settling performance and other signal degradations occur when transmitting analog signals to the flexible PC board. Sony, however, eliminated the influence of the transmission to the flexible PC board by integrating the sample-and-hold circuit in the power monitor developed in this project. This made it possible to achieve fast settling characteristics (6 ns Typ.). By integrating the sample-and-hold circuit, it became possible to assure a fully adequate sampling margin even in the narrow sampling interval in 8×-speed Blu-ray Disc recording. (See figure 7.)

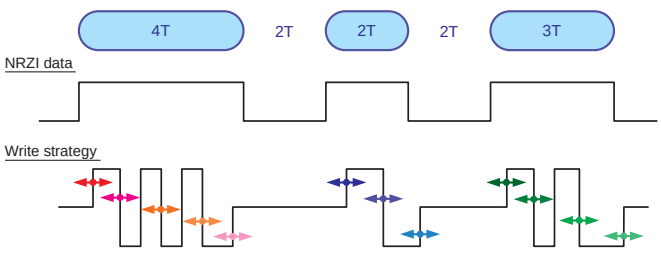
LDD

Writable optical discs record data as low reflectivity mark sections and high reflectivity space sections. It is, however, actually impossible to write data with a difference in laser power of only a factor of two. Therefore it is necessary to provide multiple levels of laser power and to control the timing of the edges where the power level changes with high precision to support a wide variety of media. This timing control function is called the write strategy (WS). (See figure 8.)
In the structure of a typical writable optical disc drive, the write strategy timing and the APC power monitoring signals are transmitted over a flexible flat cable (FFC). In 8×-speed Blu-ray Disc recording, the signal degradation due to this transmission would have a large negative impact on recording quality. (See figure 9.)

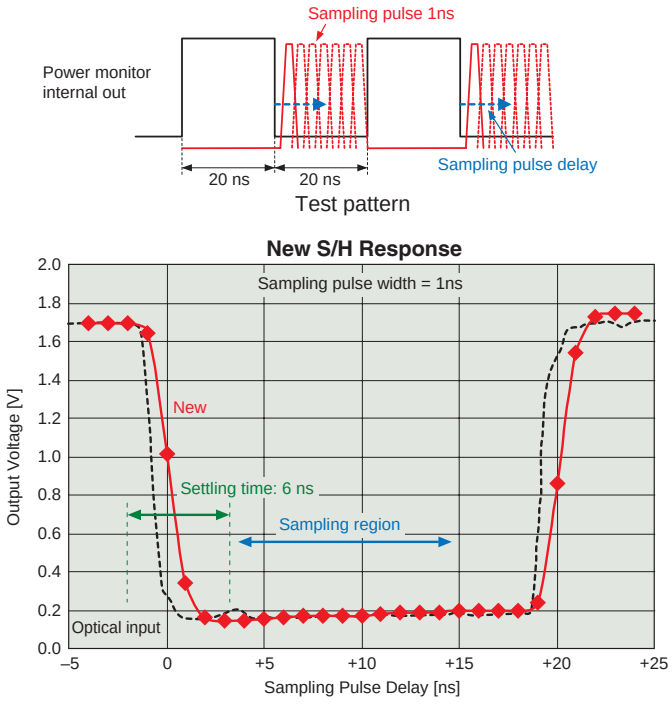
For the LDD developed in this effort Sony proposed a structure that does not require transmission of high-speed signals over a flexible flat cable by not only integrating the write strategy function, but also by supplying the sampling pulse signal from the previously mentioned power monitor PDIC that includes an integrated sample-and-hold circuit.
Sony suppressed the power consumption increase due to the write strategy integration that includes implementing complex write strategy patterns to a practical level by major revisions of the circuit architecture. Since the APC power control system also follows the current interface method, it will be easy to achieve the transition to this Sony proposed system. (See figure 10.)
While the 8×-speed Blu-ray Disc recording channel clock will be 530 MHz, these devices achieve both an adequately low jitter and a uniform 59 ps resolution as the basic performance required to assure recording quality. (See figure 11.)



■ **Figure 6 Power Monitor Structure**



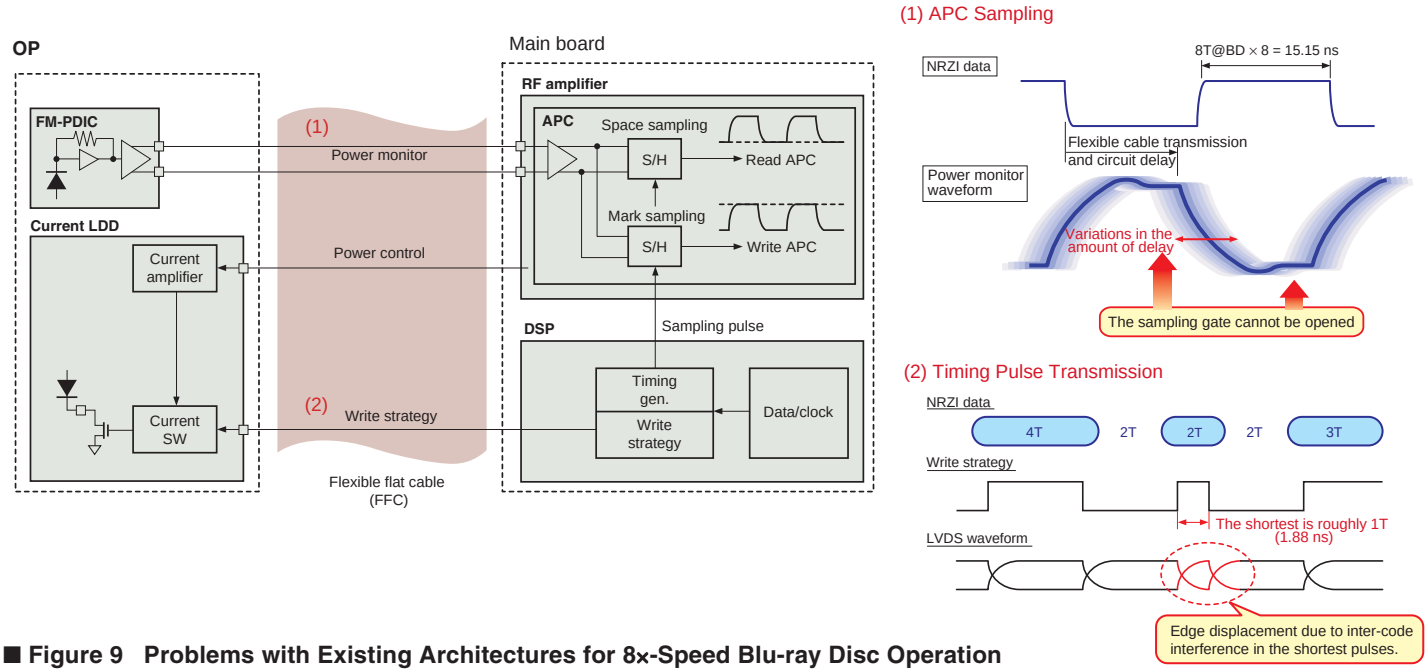
■ **Figure 8 Write Strategy Example**



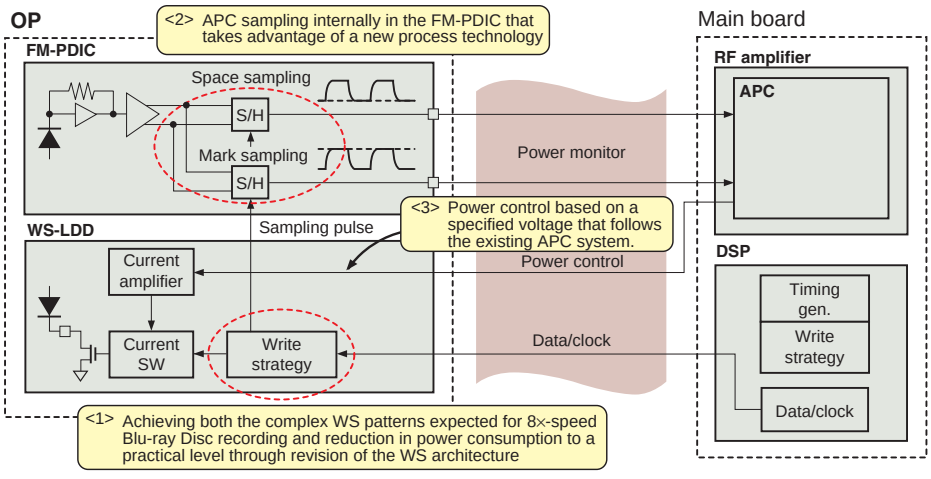
■ **Figure 7 Sample-and-Hold Characteristics Evaluation Test pattern**

Future Developments

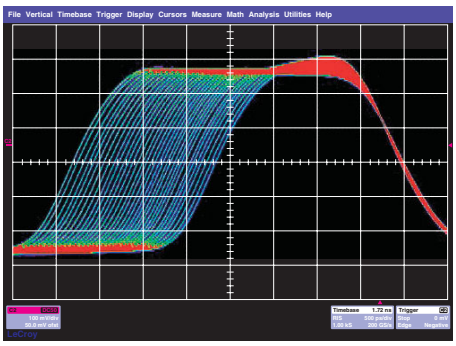
Sony has proposed devices for use in optical pickups that can achieve 8×-speed Blu-ray Disc recording and playback. Keep your eye on Sony for PDIC and LDD devices that can support higher capacities through increased Blu-ray Disc recording and playback speeds and multilayer media.



■ **Figure 9 Problems with Existing Architectures for 8×-Speed Blu-ray Disc Operation**



■ **Figure 10 Product Concepts for a Built-in Write Strategy LDD that Achieves 8×-Speed Blu-ray Disc Operation**



■ **Figure 11 8×-Speed Blu-ray Disc: 59 ps Timing Resolution**