

Integrated Optical Devices to Support the Optical Disc Market **Two-Wavelength Laser Coupler** and Laser Coupler Product Line

Two-Wavelength Laser Coupler for the Next Generation of Game **Products**

- Incorporates the industry's first monolithic twowavelength laser
- No RF mixing circuit required, operation up to 70°C
- Supports 6×-speed **DVD** and 48×-speed **CD** playback
- Separate signal processing and outputs appropriate for DVD and CD
- Circularly polarized optical output for high playability
- Miniature 16-pin ceramic package

Variations on the Laser **Coupler Theme**

- CD laser couplers
- **MD** laser couplers
- **DVD** laser couplers

Optical disc systems have now been used in a wide range of applications, from the original audio CD, to CD-ROM, MD, CD-R/RW, DVD, and DVD-ROM, and the performance of these systems has been improving rapidly. While improving the performance of the optical pickup is, of course, crucially important, the growth of the optical disc market also depends on further miniaturization, further simplification, improved reliability, and reduced costs in this critical component. The laser coupler is the device that holds the key to these improvements. The laser coupler is a hybrid integrated optical device that is implemented using an ultrahigh-precision semicon-

ductor mounting technology. By adopting the laser coupler, the optical pickup becomes surprisingly simple and reliability is increased.

The laser coupler was first developed as an ultraminiature ultra-thin form optical pickup for use in the so-called "jacket pocket size" Discman. After that, it was used not so much for the miniaturization it provides, but to reduce costs and increase reliability in Sony's current PlayStation products. This has led to its increasingly widespread adoption in portable CD players, car CD players, and CD-ROM drives. Sony is now actively promoting the development of not only CD family products, but MD and DVD



Supports 6x-speed DVD and 48x-speed CD playback



■ Figure 1 Two-Wavelength Laser Coupler

products that make use of laser couplers as well.

In this article, we focus on the technologies associated with the two-wavelength laser couplers that will be used in the next generation of game products, one of the most exciting new consumer product areas. We also present an overview of Sony's variations on the laser coupler theme.

Two-Wavelength Laser Couplers for Next-Generation Games

1) An optical pickup for the playback of both DVD and CD

Sony simplified the optical pickup system in the current PlayStations by the introduction and mass production of CD laser couplers. This achieved simplification, increased reliability, and lower costs. We have now developed the SLK3201PE two-wavelength laser coupler as the key device for implementing the two-wavelength optical pickup for the DVD/CD players that will be included in the next generation of computer game products. (See figure 1.)

"What would be the optimal pickup for DVD/CD players?"

This was the starting point of our

development effort. An exceedingly simple "ultimate" two-wavelength optical pickup can be created by providing two wavelengths on a single integrated device. (See figure 2.)

The integrated device that implements this ultimate two-wavelength optical pickup is the two-wavelength laser coupler.

This two-wavelength laser coupler adopts a newly developed monolithic two-wavelength laser, which can output laser beams with two frequencies from a single chip for the first time in the semiconductor industry. This enabled us to create an ultraminiature twowavelength integrated optical device that can be mass produced easily.

Now, we have used this two-wavelength laser coupler to reduce the number of components in the two-wavelength pickup significantly and to reduce the time required for assembly and adjustment. These contribute significantly to improved reliability and, as mentioned previously, allowed us to achieve a two-wavelength pickup that is extremely simple and easy to mass produce. We expect the two-wavelength laser coupler to be widely adopted in DVD-ROM drives, DVD video players, and a wide variety of DVD playback products as the key device that enables these products to handle both DVD and CD discs.

2) Features of the twowavelength laser coupler

Incorporates the industry's first monolithic two-wavelength laser

Sony has achieved, for the first time in the industry, the integration on a single chip of a laser structure that can output two laser frequencies, a frequency in the 780 nm band for CD playback and a frequency in the 650 nm band for DVD playback by using Sony's unique MOCVD and process technologies. (See figure 3.) Since the two positions at which laser lights are emitted are determined by the semiconductor wafer process, this laser chip achieves a high degree of precision and can easily create optical pickups with stable characteristics. At the same time, this device contributes significantly to both simplification of the optical system and miniaturization.





No RF mixing circuit required, operation up to 70°C

The SLK3201PE does not require a RF mixing circuit in either wavelength band, and achieves low noise. At the same time, it also operates at up to 70°C. Thus the SLK3201PE achieves reduced noise levels, further miniaturization, and increased reliability, and furthermore does not require measures to reduce undesired radiation. Thus the SLK3201PE contributes significantly to the implementation of simple lowcost optical pickups.

Supports 6×-speed DVD and 48×-speed CD playback

The SLK3201PE includes a high-speed PDIC based on a newly-developed ultrahigh-speed highly integrated photo IC process (P42-B; see Cx-News volume 16) and achieves a frequency bandwidth of 60 MHz. This performance allows the SLK3201PE to support 6×-speed DVD and 48×-speed CD playback.

Separate signal processing and outputs appropriate for DVD and CD

The playback signal and other systems can be switched between DVD and CD modes. While the SLK3201PE uses a differential spot size method as the focus error signal detection method for both DVD and CD, it uses a phase difference method for DVD and a pushpull method for CD for the tracking error signal detection method. (See figures 4, 5, and 6.)

For DVD playback mode, the PDIC used includes a 2-stage gain switching function which allows the SLK3201PE to support two types of disc (singlelayer and dual-layer discs) with the laser output level held fixed. Since a fixed laser output can be used, laser operating control is simplified and superb stability is provided.

Circularly polarized optical output for high playability

The SLK3201PE incorporates a newlydeveloped 1/4-wavelength plate (see figure 1), and achieves circularly polarized optical output. Thus this device is not affected by variations in disc birefringence and it can implement a high-playability optical pickup. At the same time, this device achieves even higher stability with respect to return light noise.

Miniature 16-pin ceramic package

The SLK3201PE device has a size of a mere $7.5 \times 6.5 \times 2.0$ mm. Since the SLK3201PE is provided in a miniature thin-form ceramic package that is essentially the same size as the CD playback laser couplers that are currently in mass production, it contributes significantly to miniaturization and cost reductions in two-wavelength pickups. (See figure 1.)



■ Figure 4 Pin Configuration



<PDIC block: for DVD> M.SW = Vcc

Track direction

G.SW

(Vcc/GND)



Tracking error

(push-pull)

RF signal

<For DVD> M.SW = Vcc

Phase comparator

Bo

D∘

G.SW = ground (dual-layer disc)

G.SW = Vcc (single-layer disc)







Figure 5 Circuit Block Diagram Figure 6 Signal Calculation

Variations on the Laser Coupler Theme, and Future Development

Figure 7 presents the major periods in the history of the laser coupler. Currently, the laser coupler has been deployed in a wide range of optical disc systems, including CD, MD, and DVD.

1) CD laser couplers

Originally, laser couplers were developed as ultraminiature ultra-thin optical pickups for use in "jacket pocket size" Discman products. Later they were widely used in other portable CD players, car CD players, CD-ROM drives, and more recently in Sony's current PlayStation products to reduce costs, increase reliability, and provide further miniaturization in the optical pickup. In addition to the earlier laser couplers, Sony has also developed and is mass producing 3-spot laser couplers, which provide excellent playability for CD playback. These devices are mainly used in high-end audio equipment. Sony is now developing a mold package version to provide even higher precision and a thinner form.

2) MD laser couplers

Sony has developed both playback-only and record/playback laser coupler products for portable MD players. These products adopt a simple optical structure using a KTP prism and use a high-output pulsation laser that does not require RF mixing. This allows them to implement ultraminiature high-performance MD optical pickups. The record/playback type is the first laser coupler device that supports recording.

3) DVD laser couplers

Sony has developed DVD playback laser couplers to respond to the needs associated with the growing market for both DVD video and DVD-ROM drives for computers. These products support the industry's fastest playback, 10×-speed DVD playback, by adopting a newly-developed PDIC (see the article on the new photo IC process P42-B in Cx-News volume 16), and incorporate a wide range of advanced technologies such as circularly polarized optical output and RF module-less design based on the industry's first pulsation laser guaranteed to operate at 70°C. As a result they achieve simplicity, miniaturization, and improved performance in the DVD playback optical pickup.

The previously mentioned two-wavelength laser coupler is also a kind of DVD laser coupler, and can be used in a wide range of applications as a DVD playback optical pickup.

As mentioned above, Sony's laser couplers provide extensive support for all types of optical disc systems and contribute significantly to miniaturization, cost reduction, and improved reliability in optical pickups. Sony is now actively developing devices to respond to current and future market needs and to support the further development of optical disc systems. Keep your eyes on Sony's rapidly advancing semiconductor laser and laser coupler technology.



■ Figure 7 Developments in Sony Integrated Optical Devices: Laser Couplers