New Small-size Color LED Printer

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While rapid growth of color page printers was anticipated, their spread into the office has not proceeded as expected. Reasons such as their high price, high running cost and slow printing speed have been cited as why it is harder to accept them for office use, compared to monochrome page printers.

Oki Data determined that printing speed is the key to being able to comfortably use color page printers in the office. Therefore, we have consistently brought to the market SinglePass Color® *1) LED printers that are suited to faster printing speeds.

This article introduces our new product which has an even simpler structure, is smaller and lighter, has a greatly reduced number of parts, and realizes a low price comparable to that of a multi-pass type printer while being a single-pass (tandem) type printer.

Product Concept and Target Market

(1) Current state of the color page printer market

The color page printer market is a gigantic market consisting of tens of millions of ink jet printers. Growth of the internet and proliferation of digital cameras has served to rapidly increase the spread of digitized color content. However, this content is mainly geared toward personal applications. For business applications, monochrome printers are still the mainstream. This is underscored by the composition of the printer market in 2001 when the scale of the monochrome page printer market was 11.4 million units and the scale of the color page printer market was only 700,000 units.

As mentioned above, color page printers are still used in limited environments, but in order to make them become as widespread as monochrome page printers, it is necessary to develop a product that can be used in typical offices.

(2) Product concept

Targeting the spread into typical offices, we planned the manufacture of a color page printer that would be widely used. The design objectives are as follows.

a. Low price

We made lowering prices our most important goal since this is the greatest concern of our target customers. We also made the network connection function a standard feature to allow multiple people to share printers and thus reduce the burden of a one-printer-per-user scheme.

b. Fast

We employed our own single-pass color technology, based on a set of 4 digital LED heads.

Speed is important to print comfortably in a network-connected application. Therefore, our target was to achieve the same speed as our previous printers: 12 pages/min. for color and 20 pages/min for monochrome.

c. Smaller and lighter

When taking into consideration ease-of-use and available setup space, a compact design is a must for typical offices. Our design objective was to take advantage of the characteristics of our small LED head and realize a color page printer with a size close to that of monochrome page printers for work groups and with weight that is 1/2 that of conventional models.

d. Low running cost

We responded to the needs of our target customers by employing a design that separates the toner cartridge from the image drum and by holding the cost at about the level of other high-end models.

(3) Product positioning

When comparing the GDI (Tips: see page 33) model, for example, to products sold on the domestic market in Japan, the position of the GDI model is shown by the dotted-line oval in Fig. 1. This very unique product has a color printing speed approaching that of high-speed printers while being in the low-price product group.

*1) SinglePass Color is a registered trademark of Oki Data Corp.

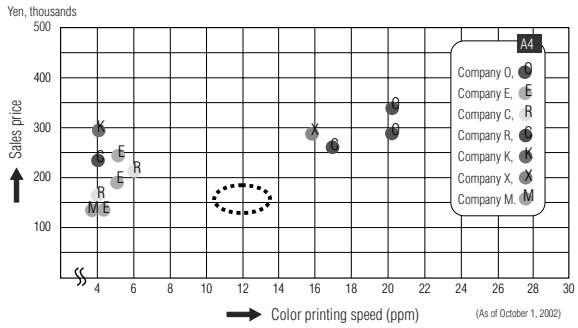


Fig. 1 Product Positioning

(4) Model line up

To meet the diverse needs of our customers, we developed two models: a PDL (see Tips: on page 33) model that is compatible with previous models and a GDI model that aims for a lower product price.

(5) Printer specification overview

Table. 1 shows the main specifications of each model.

Table. 1 Specifications

		GDI Model	PDL Model	Current Model (Reference)
Printing Technology		Set of 4 LED heads in tandem		Set of 4 LED heads in tandem
Printing Speed		12 PPM		20 PPM
Printing Speed (A4 paper)		20 PPM		24 PPM
LED Head Resolution		600 DPI		600 DPI
Printing Width		A4/Letter		A4/Letter
Supply Capacity	1st Tray	300 Sheets		530 Sheets
	Manual/ MPT	100 Sheets		100 Sheets
	Optional Tray	2nd Tray: 530 Sheets		2nd/3rd Tray: 530 Sheets x 2 Trays
	Total (Maximum)	930 Sheets		1690 Sheets
Output Capacity	Face Down	250 Sheets		500 Sheets
	Face Up	100 Sheets		100 Sheets
Double Face Printing		Optional		Optional
Outer Dimensions (W x D x H)		422 x 561 x 345 mm		430 x 620 x 430 mm
Weight (including consumables)		25.6 Kg		47.5 Kg
Emulation		GDI	PS/PCL	PS/PCL
CPU Clock		200 MHz	400 MHz	450 MHz
Standard Memory		32 MB	64 MB	64 MB
HDD		None	Optional	Optional
Local Host I/F		USB2.0	Parallel, USB2.0	Parallel, USB1.1
Network Functions		Standard		Standard (100BaseTX, TCP/IP, ATK, NW)
Driver Support		Windows	Windows/Mac	Windows
Utility Support		Network Management		Network Management
		Color Correction		Consumables Management (Sold Separately)
		Consumables Management		

Key Technology for Developing a Small, Super-light Tandem Machine

(1) A smaller, lighter printer

Previous A4 size electro-photographic color page printers were large and expensive. This was especially true for tandem type high-speed printers that tipped the scales at about 90 lbs. and sold for a price of \300,000 each. We decided that in order to develop a low-cost color printer, we would have to develop a color printer that was smaller and lighter. In an effort to reduce the total cost of the printer, we employed a sheet metal frame construction. (Fig. 2)

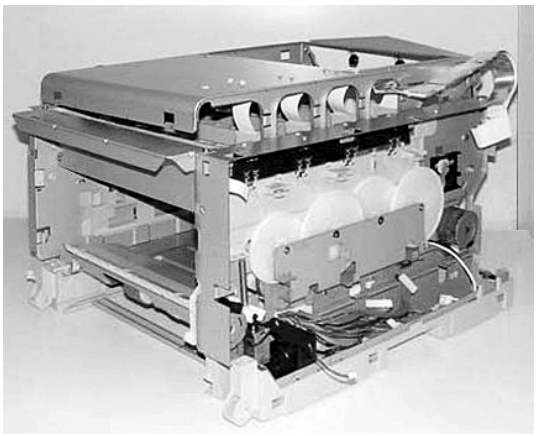


Fig. 2 Frame Construction

We did this to reduce the amount of noise emission shielding material used in the printer. In our previous models, we worked on combining parts and reducing the printer weight by employing a molded chassis frame. However, the increase in CPU operating speeds in recent years caused an increase in the resulting noise emission level. We therefore needed either shielding sheet metal that encloses the printer or many expensive parts to dampen the noise. The newly developed printer avoids this problem by concentrating all powered control circuits into a side face, using mechanized side frame sheet metal as shielding material, and employing a construction that shields the printer using this sheet metal and a single thin metal plate. (Fig. 3)

Fig. 3 Right Side of Unit

This enabled us to shield noise emissions by using just a single ferrite core in the power unit, without increasing the number of parts or making the printer heavier. Employing this layout also enabled us to use shorter and fewer connection cables for the control circuits and the power unit, and to greatly improve the ease of assembly and maintenance as well. In addition, by repeatedly performing structural analyses on the frame components, we were able to optimize the shape and mounting method of these components, while working towards using thinner walls. (Fig. 4)

As a result, we were able to reduce the weight of the unit to 25.6 Kg, approximately half the weight of the previous model.

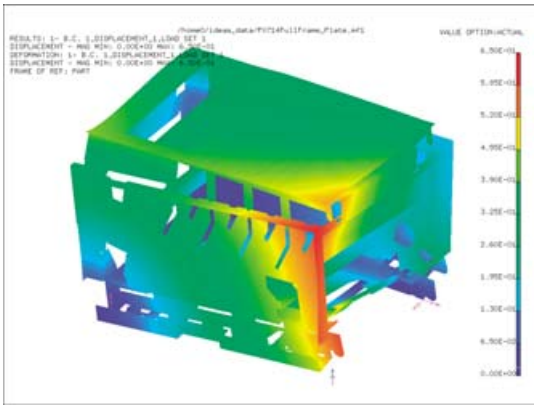


Fig. 4 Example of Structural Analysis

(2) Combined functions, smaller number of parts and fewer material types

The first thing to consider when making a product lighter and reducing its price is how to reduce the number of parts used. In the case of this printer, we also focused on combining the functions of parts other than the main frame and reducing the number of screws as much as possible. The following are a few examples.

1) Function switching using a two-direction motor

We used the forward and reverse operation of a stepping motor to achieve switching between the paper eject function and the color shift/density correction sensor shutter open/close function. In this way, we were able to reduce the number of actuators (Fig. 5).

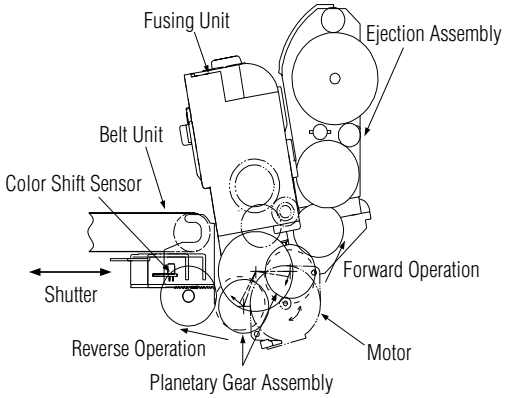


Fig. 5 Ejection Unit: Planetary Mechanism

2) Attaching parts

By using latch type plastic parts that utilize the elasticity of the plastic and employing a press-fit structure for sheet metal parts, we greatly reduced the number of screws (Fig. 6).

Fig. 6 Example of Latch Type Attachment

3) Selecting plastic materials

As much as possible, we used a uniform grade of materials and took advantage of the resulting cost benefit. Also, we worked to keep material costs down by using different parts only in those places where the required capability differed locally, such as a requirement for heat resistance or wear resistance.

By adopting a variety of measures such as these, we were able to reduce the number of parts by more than half and reduce the types of screws used by 73% compared with previous models. (Table. 2).

Table. 2 Total Number of Parts (Comparison, with previous model parameters set at 100)

	New Small Model	Previous Model
Mechanical Parts	56	100
Motors, Sensors, Switches	78	100
Substrate	90	100
Cords, Cores	49	100
Screw Types (Screws, Snap connectors, Pins)	27	100
Total	45	100

(3) Modular design

This printer employs a modular design to simplify the manufacturing process and improve ease of assembly. Modular design is a structural design in which each function unit can be divided into sub-units. This printer model consists of 11 modules (Table. 3).

Table. 3 Sub-units

Sub-units		
Base/Cassette	Density Sensor	Fixing
Side R	Top Cover	Belt
Side L	Rear Cover	Image Drum
Ejection Guide	Front	—

Fig. 7 shows the modular structure of the machine.

(4) Miniaturizing the LED head and Image Drum (ID)

We were able to reduce the ID unit pitch by 8 mm by using the new small LED head and shrinking the diameter of each roller in the ID unit. In this way, we reduced the depth of the unit in 3 locations, resulting in a total reduction of 24 mm. (Fig. 8 and Fig. 9)

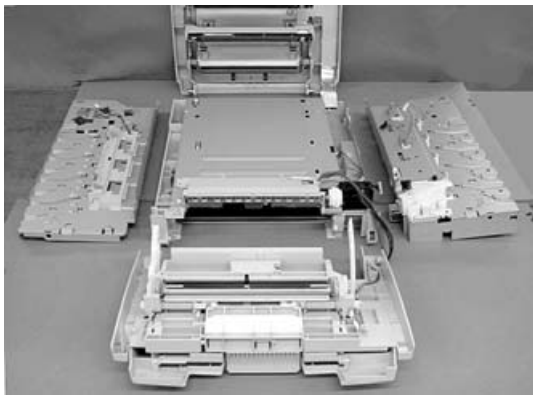
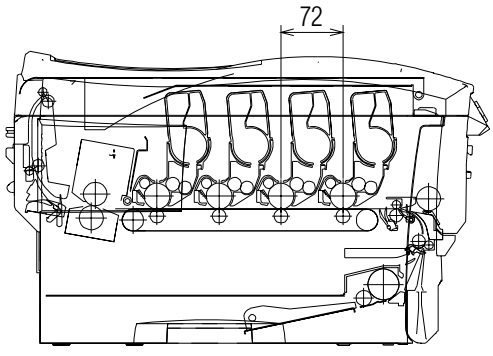


Fig. 7 Machine Modular Structure

Fig. 8 Comparison of LED Head with the previous model (left: new head; right: previous head)



Machine Layout Diagram

Fig. 9 ID Unit Arrangement

(5) Improving usability

The customer typically accesses the printer when setting paper in a tray, replacing toner, or removing paper jams. However, figuring out how to remove paper jams has been the most difficult task for the customer. By striving to make operation as simple and intuitive as possible for the customer, we concluded that a structure allowing the customer access from the front of the unit would be ideal. Therefore, we adopted the following structure.

By combining the MPT (Multi-Purpose Tray) unit and the paper transport resist roller unit into a single unit and using a lever to open or close the unit, this structure allows the customer to pull a jammed sheet out from the unit quite easily. (Fig. 10)

Fig. 10 Situation when Removing Jammed Paper

(6) Development of new fusing unit

The fusing unit of a color page printer requires more heat to fuse accumulated toner layers on paper than for a monochrome page printer. Therefore, previous printers used a large heat roller to have ample nip width. This printer however uses a combination of a small-diameter heat roller and sponge pressure-applying roller to enable color printing at 12 pages/minute.

The heat roller is made of silicon rubber. Making the pressure roller out of sponge foam enabled the nip width required for fusing toner onto paper to be maintained. Also, using one heat roller as the heat source made it possible to reduce the cost of the fusing unit and reduce its unit size (Fig. 11).

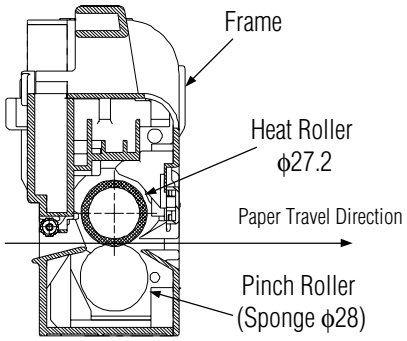


Fig. 11 Fusing Unit Cross-section

(7) Development of thin double-side printing unit

From the viewpoint of conserving resources, recent printers need a double-side printing unit that can save the amount of printing paper used. However, throughput during double-face printing decreases unless the paper travel Pass is shortened.

Since this printer offers the double-side printing unit as an option, in order to maintain adequate throughput, we reduced the size of the main unit and adopted a structure that places the paper reversing unit towards the rear of the main unit (Fig. 12, Fig. 13). We also considered usability that allows the user to set paper easily from the rear of the main unit as well.

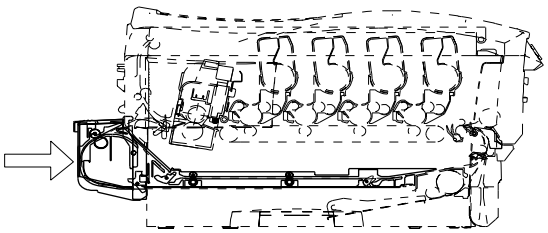


Fig. 12 Image of the Printer with the Double-side Printing Unit Mounted

Fig. 13 Double-side Printing Unit

Key Technologies of the Controller Unit

(1) PDL Controller

Since the printer engine performance is equivalent to that of previous printers, we employed the high-speed controller architecture of our previous printers even in the low-cost models.

However, in order to reduce the size of the engine, we employed two-sided high-density mounting of the QFP ASIC chips, thus reducing the board size by 38%. Fig. 14 shows a photograph comparing the PDL Controller of a previous model (A) and the PDL Controller we newly developed (B).

(2) GDI Controller

We developed the GDI Controller as a new, low-cost controller. We challenged ourselves to use ASIC technology wherever possible and to use smaller 4-layer boards. Fig. 14 compares the outer dimensions of the 6-layer PDL Controller board (B) and the 4-layer GDI Controller board (C).

Ultimately, we were able to achieve a cost level for the GDI Controller that was approximately 1/3 that of the PDL controller.

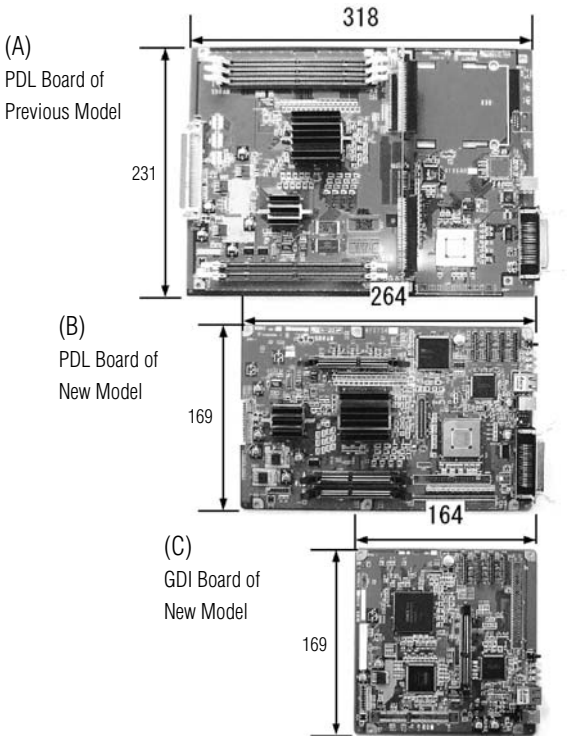


Fig. 14 Comparison of Controller Board Sizes

(3) Adoption of Hi-Speed USB

This is the first Oki Data printer to include full-spec Hi-Speed USB. We expect performance to increase as hosts become faster.

(4) Adoption of software NIC

Since we developed this new printer assuming that it will be shared by multiple users, it had to have network functionality. We therefore employed software NIC technology to achieve both high functionality (network resident) and low cost. This technology allows a single CPU to control the printer main unit and the network. The PDL Controller uses a 400 MHz CPU and the GDI Controller uses a 200 MHz CPU.

Key Technologies for Firmware Control

The product line has two printer models, but the approach we employed enabled them both to be developed. This was done by making the platform common to both, in terms of firmware, and making the hardware-dependent parts and emulation parts switchable.

(1) PDL Firmware

We were able to make good use of some of the design assets of the previous model.

(2) GDI Firmware

We developed Hiper-C, a new command set for color GDI printers, which enabled efficient data transfer and exchange of information with the Host.

(3) Network functionality

We employed advanced functions such as IPP1.1 and network PnP.

Key Technologies of the Drivers and Utilities

During development, as a fundamental rule, we gave the highest priority to maintaining compatibility with previous models.

(1) PDL driver

We utilized the design assets of previous models to ensure compatibility.

(2) GDI driver

We developed a new driver specifically for Windows © *2). Using the previously mentioned Hiper-C command set allowed us to communicate efficiently with the printers.

(3) Utilities

For both models, Oki Data supports the following utilities as a standard feature.

- Color Adjusting utility
- Network Management utility
- Accounting Operations Management Utility

Conclusion

Oki Data has been a pioneer developer of high-speed color LED printers for many years. Since announcing a product with a color printing speed of 8 pages/minute in 1998, the new printer is our 4th generation product. We completed this printer as our first printer model aimed at the broad market. Based on our previous color printer sales experience, we sought to make a product that is easier to use. Thus we incorporated the automatic color correction function and automatic color shift adjustment function that is used in the top-end model. We feel that we were able to develop a color printer that, while having a low price, does not compromise functionality or performance and is suited to replace monochrome page printers for business use.

Recently, a succession of manufacturers is announcing the introduction low-cost color page printers into the market. We expect the use of color printers in offices to increase rapidly. We at Oki Data would like to provide attractive products that accelerate the shift to color page printers in the office.

*2) Windows is a registered trademark or trademark of Microsoft Corporation.
*3) PostScript is a registered trademark of Adobe Systems Incorporated.

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TIPS Basic Glossary

GDI

The term “GDI” in “GDI printer” stands for Graphics Device Interface. This term originally referred to a rendering interface in the Windows operating system. In this article however, the term indicates an interface that renders images at the host and then sends the image data of the rendering results to the printer. Rendering then becomes unnecessary in the printer controller, and GDI printers have the characteristic of needing little CPU power and being able to operate with an inexpensive controller.

PDL

PDL printers are printers that use page description languages such as PostScript © *3) or PCL. Rendering is performed at the printer. “PDL” stands for Page Description Language.