Newly developed compact monochrome printer

Toru Miyazaki Hisao Ono
Yasuhiro Shimizu Tatsuhiko Shimomura

Electrophotographic monochrome printers, when connected to a PC are used widely as an output device for documents and graphical materials, for business as well as personal applications. It has been said that the use of color electrophotographic printers, has begun to be popular and that color printers will be replacing monochrome printers. In business, however, there are still many opportunities for the monochrome printing of documents and so monochrome printers continue to be in use. It is believed that a compact printer, capable of offering high speed and high quality printing, will continue to be accepted by the market.

This compact monochrome printer was developed as a printer to succeed the OKIPAGE™ *1) 14 (OP14) series printers, that were accepted for business use. The basic structure is the same as the existing model OP14, but the printing speed has been increased through the improvement of the electrophotographic process and the acceleration of the printing process in the print control section. The LED (light emitting diode) array head, derived from our unique technology, has been mounted in this printer to miniaturize the paper feeding system while the electrophotographic process has been implemented as a removable cartridge structure to make it possible to sustain high printing quality. Further, network functions have been upgraded to make it possible to share this printer between a small group of users, rather than limiting its use to a single user.

Phot. 1 External view of the compact monochrome printer

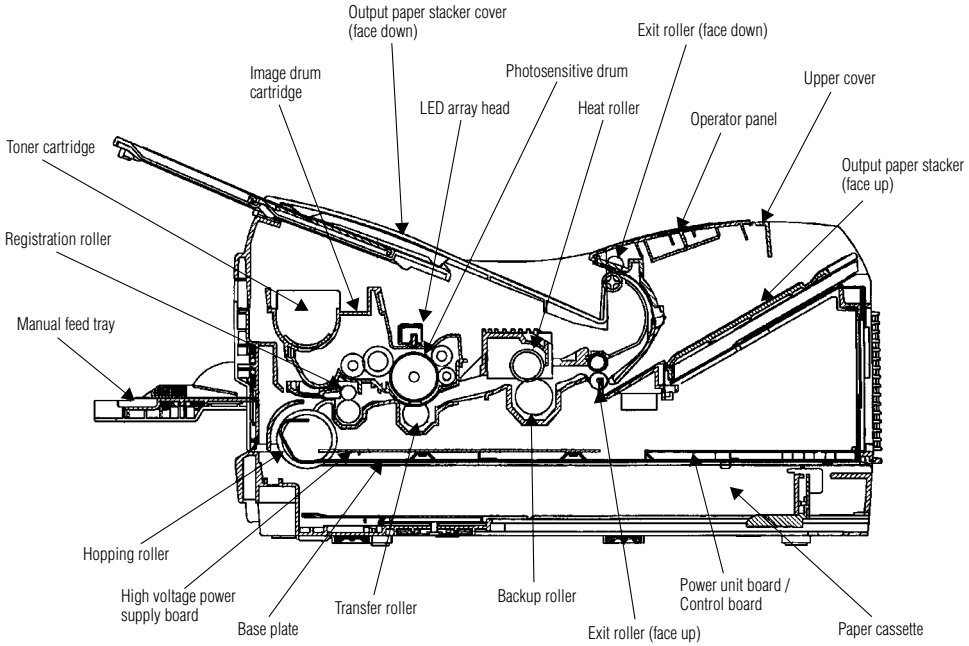


Fig. 1 Schematic configuration diagram

*1) OKIPAGE is a trademark of Oki Data Corporation.

Existing printers were accepted in business due to their compact size and high speed printing. The compact monochrome printer has been developed as a high performance product that inherits these characteristics and even though the speed of printing has been increased its size has been retained to about the same size as existing printers.

Product configuration and basic specifications

The external view of the printer is shown in Photo. 1, while the schematic configuration diagram is shown in Fig. 1. This page printer uses an electrophotographic method that optically reproduces images with an LED array head. This printer is composed of three main components as seen in Fig. 1. The three components include: The paper feeding section (paper cassette, hopping roller, registration roller, exit roller and output paper stacker); the electrophotographic processing section (LED array head, image drum cartridge, toner cartridge, transfer roller, heat roller, high voltage power supply board); and the print control / equipment mechanical section (power supply unit and control board). The basic specifications of the printer are described in Table. 1. This is an A4 size printer with a maximum paper feed width of A4 (or Letter) size. The consecutive printing speed, which represents the printing speed, is at a high speed of 18 pages per minute (18PPM) for A4 size paper. The base recording density is 600 X 600dpi. When the high resolution setting is selected the resolution in the direction of the paper feed will become 1200dpi, resulting in a resolution of 1200 X 600dpi.

Table. 1 Basic specifications

Printing method	Electrophotographic method through the exposure of individual dots.
Optical imaging method	Imaging by a LED array head.
Developing method	Non-magnetic single-element method.
Toner fusion method	Heat roller thermal fusion method.
Continuous printing speed	18 pages / minute, A4-size.
Time to first page	6.2 seconds / page, A4 size.
Printing resolution	600 dpi (dots/inch)
Paper size	From postcard to A4 size paper, Letter size and Legal size paper.
Paper cassette	250 sheets of 55kg paper (in paper cassette) and manual feed.
Output paper stacker	Face-down 150 sheets of 55kg paper. Face-up 50 sheets of 55kg paper
Emulations	PCL5e-J (2-byte), ESC/P.
Host interfaces	IEEE1284 USB (Full speed) NIC (optional)
Weight and external dimensions (WxDxH)	Approximately 9kg 355 x 395 x 200 mm
Power consumption	340W average, 700W maximum.
Options	Multipurpose feeder Expansion paper input unit

Miniaturization of the equipment has been derived by the minimizing of the path of the printing paper through the optimized positioning of the registration roller, photosensitive drum and heat roller. The first page printing time (the amount of time required from the starting up of the printer to the exiting of first printed paper on to the paper tray; excluding data processing time) is a high speed of 6.2 sec. / page for A4 size paper. For ordinary use printers are often used in a mode where a single page is printed and then the printer stops. This printer offers high speed printing even for such use.

Mechanical section

The mechanical section of this printer is comprised mainly of a paper input section, paper feeding section, electrophotographic processing section, fixing section and paper exit section.

In order to realize compact characteristics, which have been continuously inherited from existing printer models, like the OL400e, the paper cassette has been located below the main unit. This printer also inherits the reverse paper input mechanism. The paper cassette is a universal-type cassette, which supports paper sizes ranging from A6 to Letter or A4, while accommodating even the Legal 14 size, with the rear expansion frame open. The paper cassette has the capacity to hold 250 sheets of 20lb paper. The friction separation pad method, which has had a good track record with existing printer models, has been employed as the paper input method and the margin for detecting the overlapping and the no paper input signal, has been optimized. The paper input capability has been improved through the simplification of the structure, resulting from the elimination of the link used in the paper hopping mechanism that is in existing printer models. As with existing printer models, a manual feed section has been supported in this model, which features a straight paper entry path well designed for accepting OHP films, postcards, envelopes and other special mediums.

An improvement to the graphic image quality has been pursued through the implementation of an equipment structure that offers the utmost prevention of graphical image pitch variation (horizontal bars). This was achieved through the use of precision gears as drive gears in the drive section, comprised of gears that drive the photosensitive drum and transfer roller as well as by improving the backlash control and robustness of the photosensitive drum and transfer roller gears.

The paper exit section, as with existing printer models, offers a mechanism which allows for the switching of the paper output routing from face-down paper output to face-up paper output, simply by pulling up the printer's face-up output paper tray.

Electrophotographic process

The schematic diagram of the electrophotographic process of the printer is shown in Fig. 2.

The electrophotographic process of the printer is identical to that of existing printer models and involves: The application of an electrostatic charge providing an electric charge evenly over the surface of the photosensitive drum; the optical reproduction of images

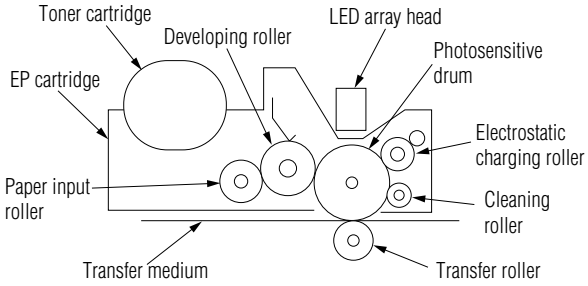


Fig. 2 Schematic diagram of the electrophotographic process

by an LED array head; the phenomenon of the development with toners attaching to a latent image on the surface of the photosensitive drum; image transfer through the electrostatic attraction of toner onto the paper; a cleaning process that clears the surface of the photosensitive drum; and a fixing process that fuses toner onto the surface of the paper.

(1) Low melting point toner

The processing speed has been accelerated, however, if the toner fusing temperature is to be raised in order to assure an acceptable toner fusion, this would result in a longer warming up time and sacrifice energy consumption of the equipment. In order to avoid this, a toner with a melting point lower than the one used in the existing printer model, OP14, is used in order to make it possible to perform toner fusion at an even lower temperature.

The capsulated structure is the same as that of low melting point toners in existing printer models, but an effort has been made to promote the fusion of the toner.

In order to assure the stability of the toner (by preventing the toner's characteristics from becoming a brittle solid, even after storage in a high temperature environment over a long period), which is contrary to its low melting point characteristics, the quantities of additives that protect the base toner, have been optimized, making it possible to satisfy both contradicting characteristics of fusion and stability.

(2) Long life drum

The friction wear resistance of the photosensitive drum, dictating the life of the image drum cartridge, has been improved by the increase in the molecular weight of the resin component, which is one of the photosensitive materials used to form the surface the photosensitive drum. This means an extended life of the consumable image drum cartridge, increasing it to 25,000 pages (continuous printing on A4 size paper), makes it possible to keep running costs at a low level.

Print control

The print control section of the printer is a new development exclusive to this printer model, which resulted from a review of the hardware architecture, to realize a performance that meets the accelerated engine speed of existing models (OP14), while lowering the price.

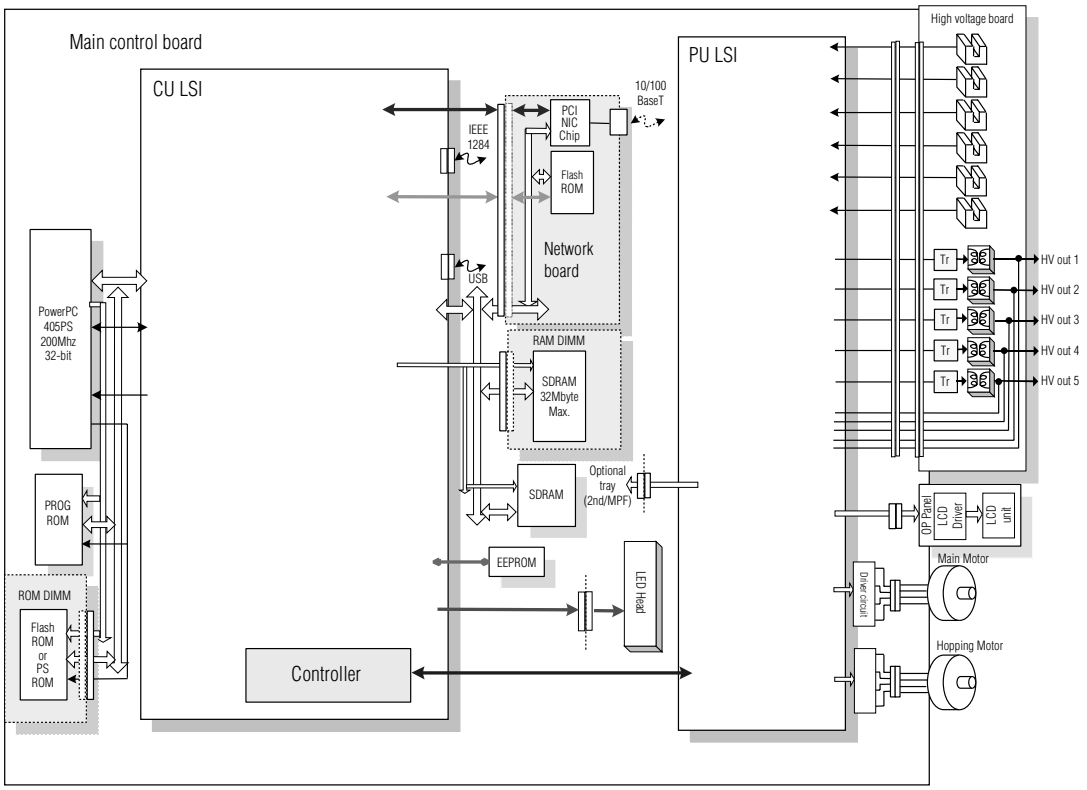


Fig. 3 Fig. 3: Control section block diagram

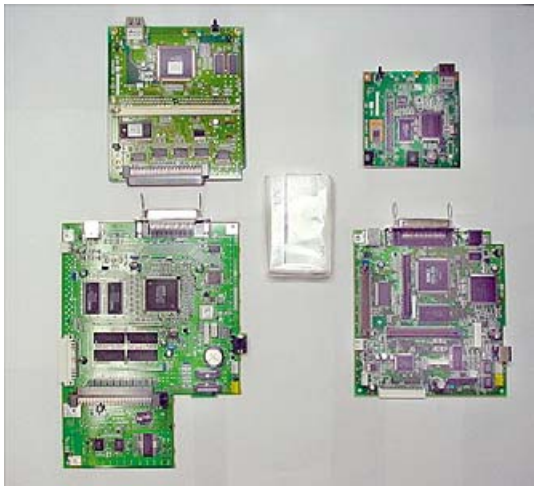
Control section hardware configuration

The block diagram of the control section of the printer is shown in Fig. 3. Although basically a single CPU-controlled equipment, similar to existing models, a control circuit, which is different from the CPU, is built into the CU (Control Unit) LSI. Further, the utmost efforts are being made to reduce the number of parts and components, such as USB control elements and other peripheral circuits, by embedding these inside the LSI. The PowerPC™ *2) 405PS (200MHz, 32-bit) manufactured by IBM™ *2) has been selected as the CPU.

The two newly developed LSIs have distributed functions, with the CU LSI performing mainly the data processing tasks, while the PU (Printer Unit) LSI mainly performs engine control tasks. Further, as its development was aimed for a bistratal control board (for emphasized cost consideration), these two LSIs are implemented in QFP packages. Furthermore, the board size miniaturization has been achieved by the optimization of the wiring patterns through advantages taken of waveform simulations.

With the control circuit, controlling the PU LSI built inside the CU LSI, much more detailed engine control, when compared with control by only one CPU, is possible and this results in a configuration that can respond to the acceleration of the engine speed. The control circuit is connected to the PU LSI and controls the mechanical control-related interfaces connected to the PU LSI. In this printer there are two stepping motors, four sensors in the paper feeding system, a toner sensor and a no paper sensor. High voltage output is also used in the electrophotographic process, as well as an operator panel and a serial interface for the optional paper input unit. These are connected to the PU LSI, and controlled by the control circuit. A Centro interface and a USB are provided as standard host interfaces, while the structure allows for an optional network interface board or an RS232C interface board. Further, an SO-DIMM socket exists for each expansion ROM and expansion RAM. The expansion ROM socket is used to add on emulations such as a PostScript® *3) language or fonts.

Finally, a photograph, representing the board size comparisons, is shown in Photo. 2. The two boards on the left side represent the main control board and the network board used in the existing printer model, while the two on the right side represent the main control board and network board of this printer.



Phot. 2 Board size comparisons

Authors

Toru Miyazaki: Oki Data Corp., Commodity Engineering Dept.-2, General Manager

Hisao Ono: Oki Data Corp., Commodity Engineering Dept.-2, Mechanical Design Team, Team Leader

Yasuhiro Shimizu: Oki Data Corp., Commodity Engineering Dept.-2, Control Design Team, Team Leader

Tatsuhiko Shimomura: Oki ID Design Team-2, Team Leader

*2) IBM and PowerPC are trademarks of IBM Corporation.
*3) PostScript is a registered trademark of Adobe Systems Inc.