Printer Technologies for Environmental Contribution -Introduction of C650 and B822/B842 Printers-

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Triggered by the SDGs (Sustainable Development Goals), awareness of the need to reduce environmental impact has risen to unprecedented levels worldwide. In addition to conventional energy conservation and recycling, environmental measures required of products and companies cover a wide range of issues including the reduction of CO_2 emissions throughout the entire supply chain, promotion of resource recirculation, and obligations to consider resource and environmental protection.

OKI's compact printers reduce CO_2 emissions throughout the entire supply chain, including the use of resources and shipping. At the same time, OKI helps customers with printing need improve their productivity and solve labor issues through the creation of space-saving and easy-to-maintain products.

This article describes two printers (C650 and B822/B842) that contribute to a sustainable society. The printers are equipped with "SpaceSavingTechnology[*1)]" that takes advantage of the compact and highly durable LED head, and have improved energy-saving performance.

Environment Contributing Technologies of A4 Color LED Printer C650

In the medical, distribution and retail industries, printings are generally done in narrow working spaces, thus compact printers are preferred. However, it is necessary to secure space not only for the printer itself and the actual printing, but also for maintenance such as replacing consumables and dealing with paper jams. OKI focused on this issue of "printer operation in a limited space" and developed the A4 color LED printer C650, which is compact (space saving), provides high performance (high productivity), and consumes low power. The C650 has the smallest chassis size in its class due to "SpaceSavingTechnology" based on three technologies described later. The space required for maintenance has been reduced 66% compared to previous models. The packaging size has also been reduced by 38% improving shipping efficiency and contributing to CO_2 reduction.

In order to further improve energy savings, the thermal efficiency of the fuser has been improved to reduce power consumption and conform to the International ENERGY STAR Program Ver.3.0. The technologies that enabled the achievement of compactness, low power consumption and high performance are described below.

(1) Mechanism for Space Saving

The three technologies behind "SpaceSaving Technology" that realizes compactness, and an airflow design that enables high-density mounting are introduced.

1) SpaceSavingTechnology

● Dual Motion Drum Basket System

In the previous model, the top cover must be opened more than 90 degrees and accessed from the top to clear paper jams or replace the image drum. However, to reduce maintenance space, full frontal access was required in the new model so that all maintenance work can be performed from the front of the printer. The C650's image drums for the four colors are mounted in a basket. When paper jam occurs, the top cover is lifted along with basket, and the jammed paper can be accessed from the front of the printer (**Photo 1 (a)**). To replace the image drum, the basket is pulled out from the front (**Photo 1 (b)**). The dual motion drum basket system makes this full frontal access possible.

(a) Paper Jam Clearing Mode (b) Image Drum Replacement Mode

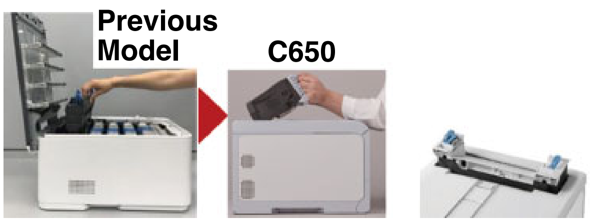
Photo 1. Dual Motion Drum Basket System

● Direct Access Fuser System

The fuser replacement of the C650 was made possible without opening the top cover. As a result, the

*1) SpaceSavingTechnology is a registered trademark of Oki Electric Industry Co., Ltd.

top clearance for maintenance, which previously required 40cm (**Figure 1 (a)**), was reduced to 20cm (**Figure 1 (b)**). To achieve this, the fuser structure partially serves as the exterior of the printer's main body (**Figure 1 (c)**), and it also forms part of the paper stacker. Furthermore, when the handle of the fuser unit is operated for replacement, the lock between the unit and the main body is released automatically, and the handle functions normally as a carrying handle. These configuration changes enable the fuser unit to be inserted and removed even with limited space above the printer such as under a desk.

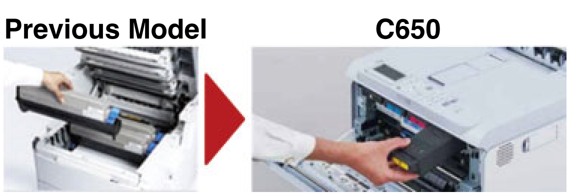


(a) Previous Fuser Replacement (b) C650 Fuser Replacement (c) Fuser Assembly

Figure 1. Direct Access Fuser System

- **Flexible Toner Transport System**

Another configurational change that enabled full frontal access was switching the toner cartridge from a parallel (**Figure 2 (a)**) to an orthogonal (**Figure 2 (b)**) placement with respect to the image drum unit.



(a) Previous Toner Cartridge Placement (b) C650 Toner Cartridge Placement

Figure 2. Flexible Toner Transport System

2) Airflow Design Enabling High-Density Mounting

In addition to SpaceSavingTechnology, the combination of high-density board and mechanism designs worked to reduce the printer size. The two-sided printing control, which was previously on a separate board, has been integrated with the main control board. That main control board and a newly developed extended wired LAN board were placed in a narrow space along the side of the printer (**Figure 3**).

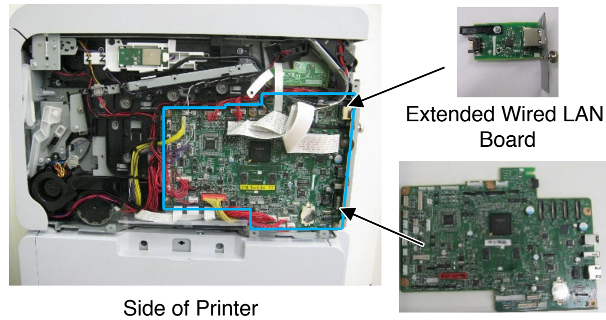
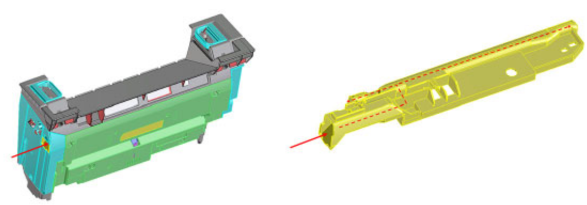


Figure 3. C650 Board Placement

However, this increased the internal temperature, but the use of a motor with a cooling function together with an airflow design reduced the temperature enabling the electrical components to maintain normal life.

For cooling the fuser, a newly designed duct evenly distributes the airflow from the main unit's cooling fan to the left and right sides (**Figure 4**).



(a) Exterior View of Fuser (b) Duct Configuration Inside Fuser

Figure 4. Fuser Cooling Mechanism

(2) Technology for Low Power Consumption

1) Energy-Saving Fuser Technology

Since much of the printer's power is consumed by the fuser, reducing its power consumption will have the greatest effect on energy conservation. Heat capacity of the member that heats the toner has been greatly minimized, and the C650's power consumption has been reduced 33% compared with the previous C610 series making the C650 conform to the International ENERGY STAR Program Ver.3.0.

2) Suppression of Power Supply Output

The full frontal access design of the C650 required an addition of a motor that increased the current flow, and therefore drawing greater output from the power supply. Optimization of the motor startup sequence and dispersion of the startup timing enabled the suppression of power supply output.

Environment Contributing Technologies of A3 Monochrome LED Printers B822/B842

The A3 monochrome LED printers B822/B842 (**Photo 2**) are products with enhanced capabilities to support form printing, which is indispensable for business printers used in national/local government offices and medical/financial markets.

(a) B822dn (b) B842dn

Photo2. B822dn and B842dn Printers

In addition to the improved print speed and a faster first print, the air cooling control is designed to suppress the heat buildup that causes drop in print speed during continuous printing, thereby enables large-volume printing of business forms.

Furthermore, to meet the limited operating space required by the customers, the components that make up the printer, the wiring and boards that connect them, and the sensors monitoring the temperatures inside and outside, which affect print quality, have been rearranged. This reduced the main body size by 43% compared with the previous model. The loading efficiency during shipping also improved 48% reducing the logistical impact on the environment.

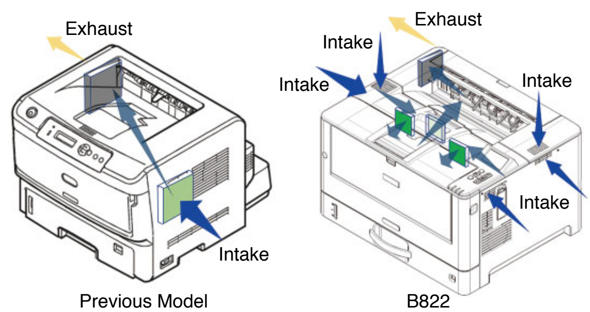
New materials were adopted for the fuser and power supply board to use the limited energy efficiently, and make the printers conform to the International ENERGY STAR Program Ver.3.0. The technologies that helped achieve this compactness, low power consumption, and high productivity are described below.

(1) Mechanism for Space Saving

1) Internal Cooling Configuration

Due to the compactness, the space for air circulation inside the printer is reduced, and the thermal insulation and cooling effects are reduced accordingly. Additionally, the fuser, which is a heat source, and image drum are arranged close to each other necessitating a higher level of cooling performance.

In order to achieve the compactness and high speed mentioned above, the cooling mechanism has been greatly redesigned. Previously, an intake fan was installed near the exterior cover to draw in outside air (**Figure 5 (a)**). However, the lack of space in the new printer's compact design does not allow adequate cooling of the image drum, and forming an air duct to the section that needs cooling is also difficult. Therefore, an intake fan was placed in a small dead space between the image drum, fuser and LED head to directly cool the image drum (**Figure 5 (b)**). The LED head frame, which would have obstructed air flow, was also configured to function as part of the air duct. Since placing the intake fan inside reduces the ability to draw in outside air, the configuration was designed to compensate by using the slight gaps on the left, right, and top of the printer as ducts.



(a) Previous Model (b) B822/B842

Figure 5. Internal Cooling Configuration

This made it possible to increase the cooling performance and print speed while reducing the size of the printer. The printer size was reduced 43% by volume and the packaging size by 41%, improving shipping efficiency and contributing to CO_2 reduction.

2) Fuser Mounting Space

As part of the energy saving measure, the diameter of the fuser roller needed to be increased, but mounting the sensor for the heat roller temperature control on the printer's main body enabled effective use of space helping the downsizing. The emitting length of the halogen heater was also optimized to minimize the width, and in the space that became available, an auto pressure mechanism (mechanism that automatically adjusts load pressure when switching between plain paper and envelopes) was implemented.

3) Issues Due to Compactness

The compactness required the electrical wiring, which conventionally ran from the left to the right side along the bottom of the printer, to be configured with an unprecedented bridging structure. In addition to the wiring being longer, the change caused such wirings as the high voltage power control signal wires to be routed through the upper part of the printer close to the LED head. Therefore, degradation in signal quality and EMC (Electromagnetic Compatibility) needed to be considered at the concept review stage, and thorough risk verification was carried out in advance to minimize the need to rework countermeasures during mass production design.

Another issue arising from the compactness was the ease at which the exhaust heat from the fuser transferred inside the printer even during short-time operation. As a result, the accuracy of the sensor monitoring air temperature outside the printer deteriorated affecting the print quality adjustment, which operates according to outside temperature.

As a countermeasure, the temperature sensor was placed at the intake of outside air for the internal cooling fan, and a new control was developed to sense outside temperature only when the fan is rotating. When the fan is not rotating, the outside temperature is estimated to adjust print quality.

(2) Technology for Low Power Consumption

1) Energy-Saving Fuser Technology

The fuser has the greatest effect on energy savings in printers. Adoption of new materials for the elemental parts of the fuser enabled the print speed to be increased from the previous 40ppm to 45ppm, and at the same time conform to the International ENERGY STAR Program Ver.3.0 (**Figure 6**).

The roller-type fuser assembly of the previous printer used an iron core in the heat roller, which has a large heat capacity, therefore making the printer difficult to conform to the International ENERGY STAR Program Ver.3.0. A method using a belt system can lower the heat capacity, but the elemental materials are too costly. To solve the problem, thin aluminum was adopted for the core in the heat roller. This lowered the heat capacity and reduced the standard power consumption (TEC value). Additionally, the halogen heater inside the heat roller was replaced with one that was higher in efficiency, improving thermal response and shortening warm-up time.

Higher print speed was achieved by increasing the outer diameters of the heat and pressure rollers, and increasing the load pressure. This expanded the contact width (nip width) between the two rollers enabling 45ppm printing.

Aluminum materials generally exhibit large decrease in strength at high temperatures, which raised concerns with wrinkles and poor fusing of the media due to eccentricity and deformation of the core metal. This problem was solved using an aluminum material with suppressed strength degradation at high temperatures.

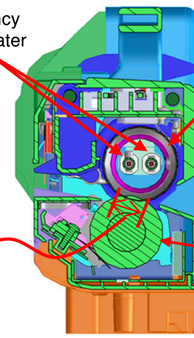


Figure 6. B822/B842 Fuser Assembly

2) Energy-Saving Control Unit

Conventionally, a single transformer was used to generate and convert the multiple voltages required within the printer. When the printer is in sleep mode and not in use, the voltage conversion efficiency is poor and hinders the reduction of power consumption. The new model divides the voltage into two types, and using a transformer for each, it was possible to convert voltage with high efficiency even when the current consumption of the printer is low, such as during sleep.

Furthermore, since the temperature sensor for the fusing unit's heat roller is mounted inside the printer's duct, a non-contact sensor used in the color printer has also been adopted in the monochrome printer for the first time. The improved sensing speed over the conventional thermistor element enables a more precise control of the heater temperature and contributes to the reduction of power consumption during printing.

Conclusion

This article introduced two printer models that were achieved through OKI's pursuit of energy-saving improvements and printer compactness. In the effort to realize a sustainable society, OKI will continue to help customers in various industries requiring printing in limited space by providing optimal printers that solve customer issues and improve workplace productivity. ◆◆

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TIPS【Glossary】

International ENERGY STAR Program
Environmental labeling system for energy-saving electrical products.

TEC (Typical Electricity Consumption) value
A numerical value based on the measurement method specified by the International ENERGY STAR Program.

fuser
Fuses toner image transferred to the paper using heat and pressure.