The World's Smallest A3 Color Digital LED Printers: C811/C831/C841

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OKI Data has been expanding sales of its C8600/C8800 and C810/C830 (C8 series) printers to the A3 Small Work Group SFP (Single Function Printer) segment, worldwide. Now, new models that are further evolved in terms of “usability”, “performance” and “ecology” have been developed. This article introduces these newly developed C811/C831/C841 printers*1). Top-of-the-line C841 model is shown in **Photo 1**.

Photo 1. C841 Printer

Target Market and Product Concept

(1) Target Market Trend

A3 color SFP market is divided into the Large Work Group (LWG) segment, in which a single device is shared by more than 100 users, the Middle Work Group (MWG) segment with 50-100 sharing users, and the Small Work Group (SWG) segment that mainly services 20-50 users. Total worldwide shipment of all segments combined tends to be flat, but the SWG segment, which is the target of the presented products, is showing an upward trend (**Figure 1**).

Since introducing the C8 series in 2006, OKI Data has steadily extended presence in the SWG segment having reached cumulative sales of 210,000 units. The new printers with enhanced features were developed to further expand sales.

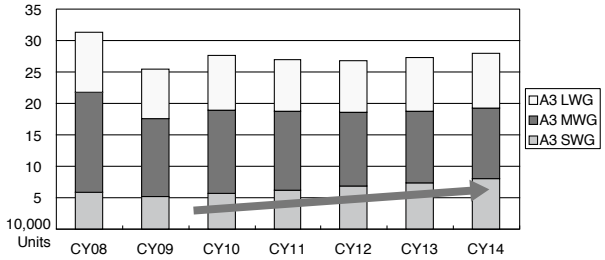

Figure 1. Worldwide Shipment Forecast of A3 Color Printers by Segment 1)

(2) Product Concept

The sales of C8 series printers to the SWG segment have enabled us to hear various comments from great number of customers. Planning for the C811/C831/C841 printers was based on the customer needs expressed in those comments. That resulted in the concept of “usability”, “performance” and “ecology”, under which the printers were developed with all renewed features.

In terms of “usability”, the new printers have the world’s smallest foot print of any A3 color printers (according to our own survey as of January 2012). The control panel display has been vastly improved especially with the easy-to-understand help screens. Despite its compact size, these printers deliver high-speed “performance” printing both color and black & white prints at 35 pages per minute. Additionally, a new fusing method has cut warm-up time down to 1/3 of conventional models enabling quick start. As for “ecology”, a new power unit reduces power consumption during standby, and an auto-off feature further reduces power usage by automatically turning the power off when the printer is not used for a certain length of time.

Key Mechanical Technologies

(1) Compacting Printer Size

In order to achieve the world’s smallest A3 color printer, effective use of space inside the printer was required. The resulting models took up only 84% volume

*1) “C811” is for Japanese market only. “C831” is for overseas market only.

and 80% of the footprint when compared with previous models (**Table 1**).

The following specific changes were made.

1) Paper passage route was tilted to allow the duplex printing unit and low-voltage power supply to be placed underneath. This reduced the depth and width of the printer (**Figure 2**).

2) Changing the paper size detection switch from a horizontal to a vertical position and placing the image drum drive motor on the inner side of the side frame reduced printer width.

3) Engine control board and controller board were integrated into a single board then the board placement was revised to improve implementation efficiency.

Table 1. Size Comparison (includes duplex printing unit)

	C810/C830	C811/C831/ C841	New/Old Ratio
Width	485 mm	449 mm	92%
Depth	634 mm	552 mm	87%
Height	345 mm	360 mm	104%
Volume	106 cm^3	89 cm^3	84%
Footprint	3075 cm^2	2478 cm^2	80%

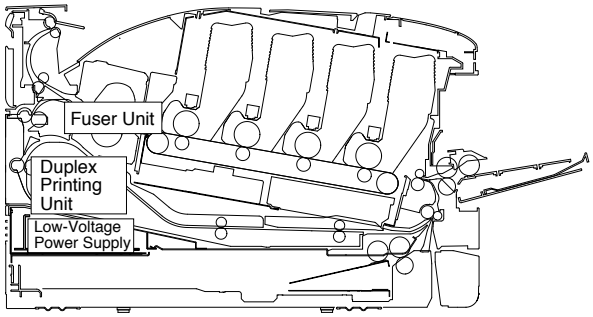

Figure 2. C811/C831/C841 Cross-Sectional View

(2) Noise Reduction

Numerous noise reduction measures were implemented while increasing print speed to 35ppm from the previous model's 32ppm.

1) Reducing paper discharge noise

In addition to adopting a metal shaft to lessen the periodic sound caused by the eccentricity of the resin shaft, gear train driving the paper discharge roller was replaced with a low-noise belt drive.

2) Reducing paper feed noise

In order to prevent the flapping sound at the sheet path end between paper and registration roller, shape of the paper path was revised. Furthermore, the spur gears in the paper feed gear train were changed to helical gears, and drive switching system was replaced with an actuator which does not produce operating noise. Using a slower feeding speed minimized the rubbing sound made by the papers.

3) Reducing vibrations

Drive motors for the image drum and duplex printing, which are sources of vibration, are now secured with thicker support plates. Use of a low-noise motor for the heavy vibrating duplex printing drive further decreased noise.

4) Reducing fan noise

Low-noise fans were adopted for cooling the low-voltage power supply and fuser. Additionally, the temperature of the power supply is monitored enabling the fan to normally spin at low speeds, and only run full speed when a prescribed temperature is exceeded. Also, the transition time to power save mode has been shortened, and the fan is controlled to stop immediately after printing is completed.

As shown in **Table 2**, implementation of these measures remarkably reduced printer noise compared with previous models.

Table 2. Noise Comparison

	C810/C830	C811/C831/C841
Printing	54dBA (@ 32ppm)	52dBA (@ 35ppm)
Standby	37dBA	32dBA

(3) Dealing with Heat Buildup during Continuous Printing

One of the challenges in designing compact high-speed printers is dealing with internal heat generation during continuous printing. The new printers have revised cooling fan layouts, and duct work was devised that improves internal airflow to efficiently pass outside air over the heat generating parts. This enabled us to achieve compactness and speed while dramatically improving the capacity of continuous prints (**Figure 3**).

Key Fusing Technologies

In order to satisfy customer usability while pursuing lower power consumption, it was necessary to develop a fuser with short warm-up time. Unlike the previously used pressure-side belt system, the fuser in the new models employs a low heat capacity fuser belt on the heating

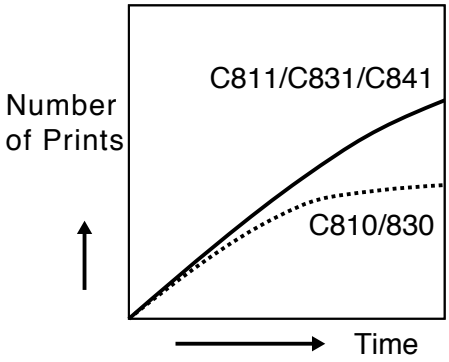

Figure 3. Throughput Comparison of Continuous Duplex Printings

side, and the belt is directly heated with a newly developed metal heater. Optimized design of the fuser assembly also allowed the width of the fuser nip to be widened for faster printing speeds thus further improving customer usability (**Figure 4**, **Table 3**).

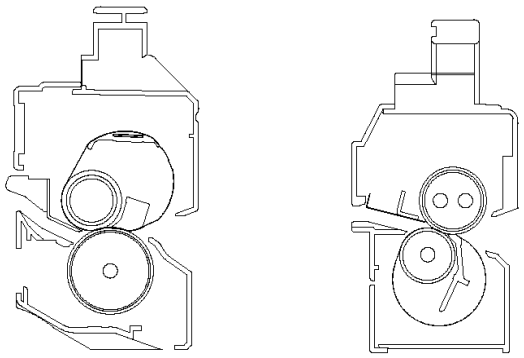

Figure 4. Cross-Sectional Comparison of Fuser Units

Table 3. Comparison of Print Speeds and Warm-Up Times

Model	Previous	C811/C831/ C841	New/Old Ratio
Print Speed [ppm]	30	35	117%
Warm-Up Time [sec]	90	32	35%

(1) Reducing Warm-Up Time

Warm-up time of the fuser unit is heavily dependent on efficiency of heat transfer from heating source to the heated element and thermal capacity of the heated element. In this development, the switch from a fuser roller to a thin fuser belt helped greatly reduce the heat capacity. The newly developed metal heater used in the printers is composed of a metallic plate surface heater and aluminum supports that efficiently transfers heat from heater to fuser belt. With this method, heat is directly transferred from the surface heater to the low heat capacity fuser belt providing better heating efficiency than the halogen heater used in a traditional fuser unit. As a result, warm-up time is approximately 35% of conventional models, a significant reduction.

(2) Faster Print Speed

In developing the printers, faster print speed was achieved with improvement of the fuser unit. This includes the optimally designed fuser assembly that accommodates a wider fuser nip.

The fuser nip located inside the fuser belt consists of the fuser roller and pressure pad. Unfortunately, widening the nip only with the pressure pad drastically increases sliding torque. When the method to directly heat the fuser belt was adopted, thicker rubber was used to better insulate the fuser roller surface from heat. The characteristic of this thicker rubber was utilized to expand the nip width.

As a result, width of the fuser nip was increased approximately 30% over conventional models without the drastic increase in driving torque enabling high-speed 35ppm color printing.

Key Hardware Control Technologies

In order to significantly cut power consumption while pursuing ecology and usability, power control of the entire printer was redesigned.

Fractional-N digital control that utilizes a piezoelectric transformer was adopted for the transfer bias reducing rated power consumption of the high-voltage power supply by 25%.

Previous power-cutting measure during non-operation only included a “sleep mode” which printers switched to when they do not receive a print job for certain period of time, but the new printers also have a “off mode” that turns AC power off after an additional period has elapsed. To implement off mode, power control was equipped with a dedicated, low-power CPU, and AC on/off circuitry is software controlled.

Sleep mode itself has also been thoroughly re-examined to further reduce power consumption (**Table 4**).

Table 4. Power Consumptions during Non-Operation (100V Models)

Mode	Previous (A4)	C811/C831/ C841	Comparison
Sleep	Less than 0.9W	Less than 0.7W	Reduced PWR consumption
Off	-	Less than 0.1W	New feature

Off mode has become a requirement under European Commission's ErP Ecodesign Directive Lot 6 Tier 2 (effective January 2013), however the new printers easily meet the 0.5W requirement specified by the directive. The dedicated CPU and software power control not only reduced power consumption, but improved usability as well.

Software power control eliminated the placement constraint of the power switch enabling the switch to be relocated to the front of the printer where it is more accessible. User operation when turning off the power has also been simplified. With the previous models, the user needed to perform a shutdown operation before mechanically turning the AC switch off. In the new printers, series of processes are automated, so the user is able to turn the power off with a single operation.

During the off mode, opening/closing of the printer cover is monitored, and it determines if preliminary operation such as color shift correction is required. This reduces redundant correction processes for a shorter startup time and conserves consumables.

Key Firmware Technologies

While adhering to the functionality of previous color printers, firmware performance was improved and new functions were added. As a result, usability has been enhanced and energy saving/low running cost was achieved. Usability and convenience features of the control panel are described below.

(1) Control Panel Usability

C811/C831/C841 printers use the control panel layout shown in **Figure 5**. It includes eight function buttons, a numeric keypad, three LEDs (one integrated into the power save button), and a 2.5 inch LCD display.

Figure 5. C811/C831/C841 Control Panel

1) Panel Display

The standby screen has two display patterns as shown in **Figure 6**. The top two lines display printer status and warnings while the bottom three are selectable by the user to either display the toner gauge or paper size of each tray.

Figure 6. Standby Display (user switchable)

When an error occurs, a message is displayed on the entire screen as shown in **Figure 7**. If the entire message does not fit on the screen, the message will scroll one line at a time, ensuring convenience. When it is necessary to replace consumables or a paper jam occurs, screen will alternately display a message and animation for easy and intuitive understanding.

Figure 7. Error Display (two screens alternately displayed)

Pressing the Help button on the control panel displays messages that describe how to deal with different types of errors (**Figure 8**). First line displays the title and page (current page number/total number of pages). The second and subsequent lines display the body of the help message. ∧ and ∨ buttons can be used to scroll from one page to another.

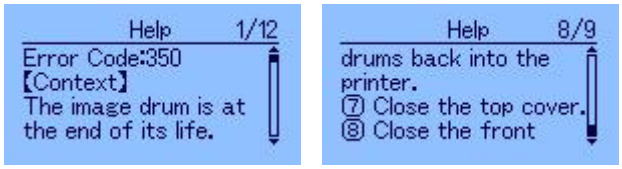

Figure 8. Help Display

To provide users with appropriate and easy to understand messages, all messages (error and help messages) have been revised*2).

Error messages were improved to clearly describe error situations and solutions with plain words. For example, rather than using the term "memory overflow", the same error is described as "Printing data is too large, and there is not enough memory.", and the solution is displayed as "To continue printing, press the online button" instead of simply displaying "Press the online button."

For help messages, terms such as names of consumables were corrected to provide uniformity, and

*2) Revised control panel messages apply to Japanese models only.

actions required by the user were revised to be more specific. For example, “Grasp fuser handle, remove and then re-set.” was changed to “Grasp the handle on the fuser unit, remove then place back into printer.”

2) Operation

This is the first time our printers have been equipped with a numeric keypad. It improves operability by enabling input of passwords for print authentication, IP addresses and other numeric information.

The numeric keypad is also used to perform functions. Pressing the function (Fn) key (“*” key) followed by a three-digit number allows the user to directly access the setup menu or initiate a certain function (**Figure 9**). It eliminates the need to navigate through the menu hierarchy and can be useful, for example requesting another user over the telephone to operate the printer.

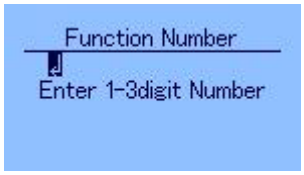

Figure 9. Function Key Operation

A cancel function is necessary for halting a print job due to operational mistake. When the Cancel key on the control panel is pressed, printing is temporary stopped and a confirmation screen similar to that shown in **Figure 10** is displayed. The display ensures the cancel operation is carried out, and also allows the user to resume (continue) printing if the Cancel key was accidentally pressed.

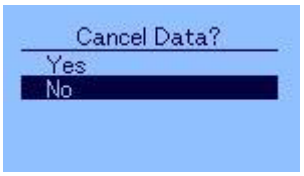

Figure 10 Cancelling Print Job

As described above, various settings and functions are possible using the control panel, but a panel lockout feature has been implemented to prevent accidental operations such as mistakenly changing settings. When this feature is turned on, all control panel operations, except the Cancel key, are disabled.

(2) Convenience Features

1) Auto-Off

In addition to the sleep mode introduced with the C610/C711, these new printers are OKI’s first to be implemented with off mode[2]. When the power switch is pushed, this feature will run through a shutdown operation before turning off the power. Also, the printer can be made to power off automatically if there is no print job for certain length of time.

2) Print Control

New dithering that was adopted results in smoother and more beautiful gradations. The 1200dpi print head used in the C841 produces high resolution prints.

Feature to print in black & white when there is no color toner has been carried over from the previous models.

Toner save feature allows the user to set the amount of toner to save in three stages. Furthermore, there is an option to save or not save toner for portions printed in 100% black such as texts and lines. This enables the user to easily make print settings depending on whether the print is for submission or a sample print.

Summary

The printers described in this article were developed to meet customer needs with improved “usability” and high “performance” while being environmentally conscious “ecology” products. OKI will continue to reflect customer and market voices into development of products that will increase customer satisfaction. ◆◆

References

1) OKI Data analysis based on IDC “Worldwide Quarterly Hardcopy Peripherals Tracker” CY2010Q
2) COMMISSION REGULATION(EC) No 1275/2008 of 17 December 2008 “Implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment”

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TIPS

【Glossary】

Fractional-N digital control scheme

Scheme applies the frequency generation technology of fractional-N PLL (Phase-Locked Loop) synthesizer to the piezoelectric transformer drive frequency generation. Focusing on high-speed lock-up characteristics of fractional-N PLL, it was possible to apply the scheme to high-speed control.

Shutdown operation

Operation required before power is turned off on C810/C830 and other previous printer models. Power button is pressed and held down while access to the internal HDD and non-volatile memory is forcibly terminated.

Sleep mode

Low power consumption mode to which the printer transitions when not in use.

ErP Ecodesign Directive Lot 6 Tier 2

Energy saving regulations based on the EU directive (1275/2008/EC). Tier 2 represents the second stage.

Off mode

Mode in which the equipment is connected to a power source, but no functionality is provided by the equipment.