

Compact/High Performance A4 Monochrome Multi Function Printers: MB400 Series

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During the obvious price competition due to changes in economic conditions, printers are seeing a prominent move toward networking and integration with copiers to cope with the increasingly sophisticated user environment. This has led to a large demand for MFPs (Multi Function Printers). In response to this market, OKI Data has taken the scanner technology from its highly successful color MFP, which is based on print technologies achieved from years of expertise with SFPs (Single Function Printers), and from both high performance and manufacturing cost reduction approaches developed the MB400 Series MFPs (Photo 1).

Some key points from development to product launch are presented below.



Photo 1. MB480

Target Market Trends

As shown in Figure 1, after the 2008 economic downturn, shipments of monochrome SFPs dropped drastically, but the decrease was not as great for monochrome MFPs. There are three possible factors for this.

(1) Multi functionality

In contrast to the print-only function of the SFP, MFP

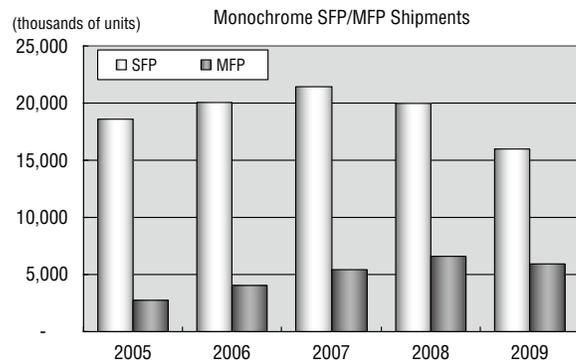


Figure 1. Worldwide Printing Machine Shipments ^{Reference 1)}
(For monochrome laser printer-based flatbed scanner category)

with its copy, fax and scanner functions can convert media information into electronic data for storage in servers and PCs, or for sending via email. The capability to use these functionalities for work improvement is one of the likely reasons MFP shipments are on the rise.

(2) Low running costs

Businesses today make extensive use of graphical presentations and easy to understand color-coded charts in their documents. A color printing machine would be required to print those documents, but if all machines are made color capable, users will likely print out more documents in color than is necessary raising concern for ballooning running costs including consumables. As a result, more businesses are prohibiting color printouts or are purchasing monochrome machines, which are cheaper and use lower cost consumables.

(3) Low unit cost/compact

Monochrome machines are cheaper to deploy than color. Therefore, monochrome machines are increasingly being chosen for additional purchases. Demand for printing machines in BRICs and other emerging economies are also growing, but many of those customers are choosing low-cost monochrome MFPs which cover scanning, copying and faxing. More and more of the first time purchases in these regions are monochrome MFPs.

Next, the trend of the desktop MB400 Series' target market, which is high-speed monochrome MFP shared over a network by about five users, is examined. As shown in **Figure 2**, this is an expanding market riding the big wave of the monochrome MFP market growth. Numerous vendors are engaged in a fierce price competition while working to provide higher speeds and advanced features.

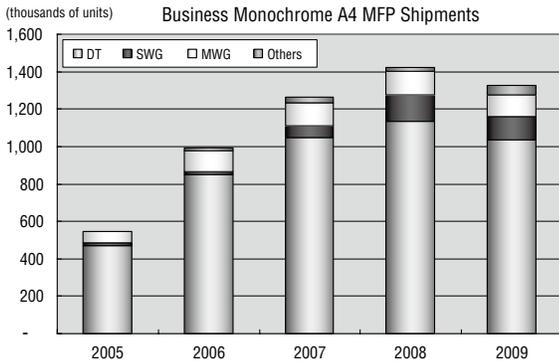


Figure 2. Monochrome MFP Shipments by Segment
(For monochrome laser printer-based flatbed scanner category)
* OKI Data's summarization based on Reference 1)

Three models were developed for the MB400 Series. The least expensive MB460 is a 3-in-1 machine with printer, copier and color scanner functions. The 4-in-1 MB470 adds fax functionality, and the top model MB480 comes with a large capacity paper tray.

The competitive landscape of the target desktop segment is shown in **Figure 3**. Our models maintain prices that are at or below the market leading vendors A and B. The large-capacity toner cartridges that come with the MB400 Series are good for maximum of 12,000 sheets (ISO 19752 compliant) offering customers savings in total cost.

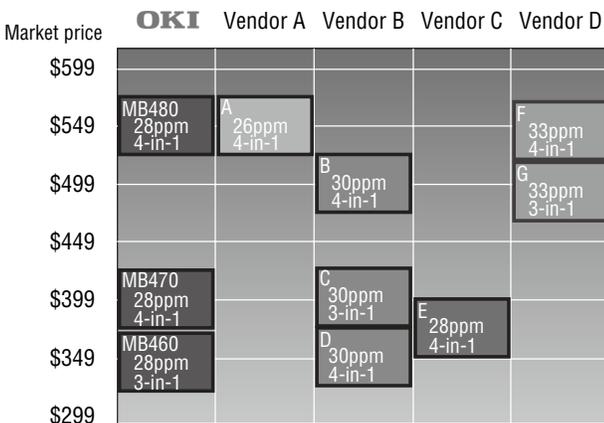


Figure 3. Competitive Landscape of Target Segment

Technical Challenges during Development

(1) Scanner unit installation

The molded mainframe of the monochrome printer that was used as a base did not possess the strength to hold the weight of the scanner. In order to reduce the load on the mainframe, adding metal plates to both sides of the printer was considered.

However, simply adding the metal plates will significantly increase the weight of the machine. Using CAD analysis, the metal plates in the prototype were checked for thickness that would ensure the necessary strength.

As shown in **Figure 4**, concentration of stress is avoided with a metal plate/molded cover combination and area surrounding the metal plate is minimized. In the resulting structure, the 1.2mm thick metal plates adopted from the color machines were reduced to 0.8mm. This helped to hold down weight gain, but structural strength is the same as the color machine.

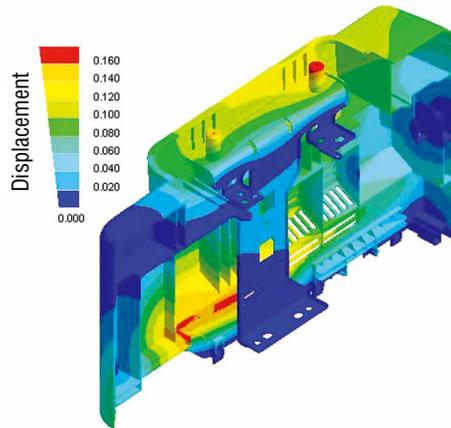


Figure 4. CAD Analysis of Stay Design

(2) Control panel

There have always been requests from customers for an easy way to set and recall frequently called fax numbers. Unfortunately, enlarging the control panel on the base monochrome printer to accommodate the extra fax keys made it difficult to view and reach for the printed sheets. Therefore, shape of the control panel used for the color scanner unit was adopted, and without making major changes, five one-touch keys and one shift key were added enabling users to set ten fax numbers (**Figure 5**).

(3) Faster scanner unit

Scanner unit from the color machine capable of scanning 10CPM (Copies Per Minute) in color and 20CPM in monochrome was to be used. However, to take



Figure 5. Control Panel Layout

advantage of the printer engine's speed during the copy operation, we proceeded to increase the scanning speed in monochrome mode.

For standardization purpose, we restricted ourselves from making changes to basic components of the scanner including the CCD (Charge Coupled Device: photoelectric conversion element), optical lenses and cold cathode fluorescent light source. By re-examining and improving the timing of the scan cycle, we managed to speed up the scanning to 25CPM.

Since CCD is a device that normally outputs voltage proportional to the amount of light received in a given period of time, if the scanning cycle is shortened, the amount of received light is reduced causing lower output signals from the CCD and degradation in S/N ratio.

S/N ratio degradation leads to poor copy quality such as deterioration in color uniformity and tone reproduction. In this development, rather than taking the results of individual adjustments, an optimal image adjustment was performed by treating signal quality, image quality and image processing as a whole. This enabled us to increase speed while minimizing overall degradation.

(4) Introduction of an analog simulator

Implementation of countermeasures is necessary to block unwanted electromagnetic noise from adversely affecting other electronic equipment. In order to reduce development time, an analog simulator was brought in for waveform analysis.

Shielding the CCD image signal cable is an effective way to guard against electromagnetic noise. However, strength of the shielding material is insufficient for the moving portion leaving only the fixed portion to be adequately shielded (Figure 6). Furthermore, shielding degrades waveform quality of the CCD analog signal making it necessary to evaluate several shield combinations.

Using the analog simulator, circuit parameters were narrowed down through simulation of various transmission lines including FFC (Flexible Flat Cable) to reduce time and make the material showing supportive logical evidence.

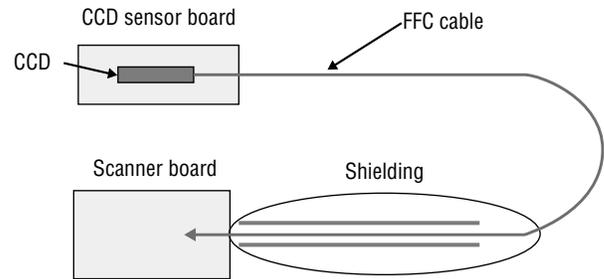


Figure 6. Cable Shielding to Block Electromagnetic Noise

Quiet Power-Saving Design

Although the scanner unit was ported over from the color machine, significant changes were made to the power circuit for a more quiet power-saving design. Previously, the printer engine supplied 30V to the scanner unit from which six different voltages were generated on the scanner control board. The three-terminal regulator configuration used for the power circuit was inexpensive but very inefficient. Much of the power was lost as heat that needed to be dissipated with a cooling fan, which in turn created noise during the standby mode.

We decided to review the scanner power circuit and find low cost solutions to achieve the following.

- 1) Turn off scanner power in power-saving mode
- 2) Eliminate scanner unit cooling fan

First, power from the printer engine was changed to two supply circuits of 24V and 5V. On the scanner board, only three low loss DC-DC converter circuits were used.

Additionally, MOSFET was used for controlling power supplied from the printer engine so that the power to the scanner can be switched off in power-saving mode (Figure 7).

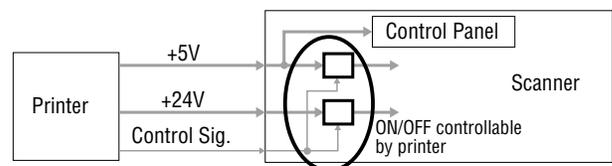


Figure 7. Changes to the Scanner Power Supply Circuit

Additional Features and Improvements

(1) ID card copying

Traditionally, if a copy of an ID card such as a driver's license is required, two sheets of paper were necessary

to copy both front and back of the card. Furthermore, copying a small card on to an A4 media leaves large amounts of blank space, which is a waste of paper.

Therefore, we provided a copy menu especially for ID card copying, which scans both sides of the card then makes a same-sized aggregate copy of the image data on to a single sheet of paper. This cuts paper usage in half without sacrificing user convenience.

(2) Multiple copies (Collate Copying)

When multiple copies of a multi-page original are to be made, image data of the all pages scanned from the original must be saved in memory. Previously, image data was saved to memory as scanned without any processing. Hence, if the original contains numerous pages, there would be insufficient memory to store the data for multiple copies. In such a case, users were required to add additional memory.

In the newly developed models, the scanned images are compressed in real-time using lossless data compression to reduce data size. The compression and decompression processing are performed by utilizing the functionality of the LSI used for printing in the printer engine. This enables multiple copies of more originals without adding special hardware.

(3) MPS (Managed Print Service) support

Until recently, it was common for customers to purchase and own printers and consumables (image drums and toners). Now, there is a migration toward MPS, in which corporate customers are provided with solutions that greatly reduce costs related to document printing through optimization of the company's entire document data and output equipment including printers, faxes and copiers.

MPS is a billing business model. Customers are not required to purchase individual printers, MFPs or consumables. Instead, they are charged usage fees corresponding to number of printouts they make.

MB400 Series is equipped with a print counter that is billing business model compatible ensuring MPS support.

Conclusion

By combining a scanner with a printer engine, we succeeded in achieving compact monochrome MFPs that provide both high performance and high reliability all at a low cost. We plan to continue developing products that meet customer needs in a timely manner. ◆◆

References

- 1) IDC, "Worldwide Quarterly Hardcopy Peripherals Tracker", 2010Q2

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