Development of High Quality True Edge Printhead for Card Printer

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Abstract

Recently, full color thermal printing on plastic cards requires more diverse imagery capability and faster print speeds. The ID card printer application is one of several applications impacted by these requirements. High speed print with a thermal printhead may result in print quality degradation caused by excess power consumption in the common bus and heat accumulation interpretation. These two critical factors need to be controlled to achieve high speed printing.

The purpose of this paper is to introduce a unique printhead construction that realizes improved print image quality under high speed printing conditions. An optimized electrode pattern designed for high current conditions reduces common power consumption without changing the printhead size significantly, Additionally, enhancement of printhead temperature detection is achieved by increasing the temperature feedback speed to the control board. These changes will result in high speed print output with improved print quality.

True edge printhead construction

To print on plastic card, printhead needs to accept flat pass which there is nothing to contact with the card before and after heater line. Laser and ink jet print method can give this flat pass. However, in this paper, thermal type true edge printhead for card printer application is discussed.

This true edge printhead construction is that heater line is right on the true edge. And, driver IC which controls heating of resister elements is one side of the substrate surface. As a result, there is nothing before and after heater line as shown in Figure 1.

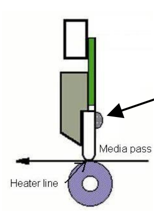
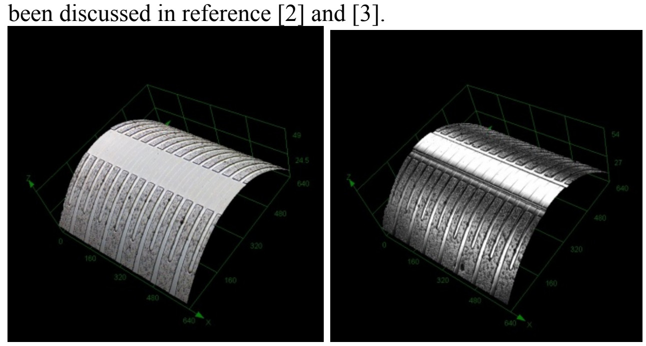


Figure 1. Printhead type

Also, due to the application is ID card printer, print quality needs to be high. Then, the thermal printhead heater line surface which contact to the media must be smooth enough. There are different types of flat pass printhead which are called near edge printhead and corner edge printhead. However, those types of printhead don't give the enough smoothness for ID card printing. Only true edge printhead can achieve enough smoothness for ID card printing. And, related subject is in reference [1].

The issues to improve print speed and quality

To increase print speed by dye sublimation card printing, optimized printhead angle window which is limited by ribbon wrinkle and optical density fall out must be wider. To make this window wide, double partial glaze construction is adopted as shown in figure 2. Then, ribbon wrinkle has been removed without optical density fall out. As a result, print speed has been increased in real application from 1.5 ips to 2.0ips. Also, this subject has been discussed in reference [2] and [3].



Partial glaze   Double partial glaze

Figure 2. Glaze type

Then, to achieve higher print speed, higher applied power is required. To apply higher power, resistance value needs to be lower. However, resistance value was limited by common bus capability. This common bus is the common electrode against individual electrode to connect to the driver IC which controls the switching of the heater. Then, resistance of this common bus needs to be small. If it is enough small, common bus is capable to accept lower heater resistance value. Current true edge printhead construction has thin film common bus at the both left and right side edge of ceramic substrate. To lower the resistance value with current common bus construction, significant common bus power consumption may happened and affect to the print quality lower, because of limited common bus capability. To avoid it, common bus construction needs to be changed.

Also, to get stable print optical density during printing a card, two things are required. One is real time temperature detection of ceramic substrate by thermistor to apply real time temperature compensation. The other is higher heat dissipation construction to remove excessive heat accumulation in the ceramic substrate.

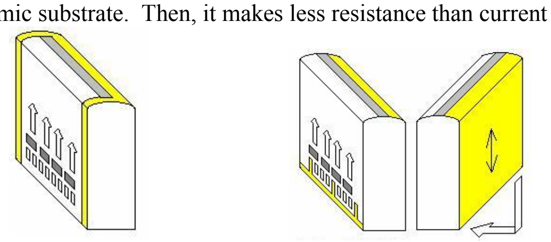
So, there are three kinds of issues are raised to improve print speed and quality.

1. Improved common bus construction
2. Real time temperature detection of ceramic
3. Higher heat dissipation construction.

Solutions will be discussed in below.

Improved common bus construction

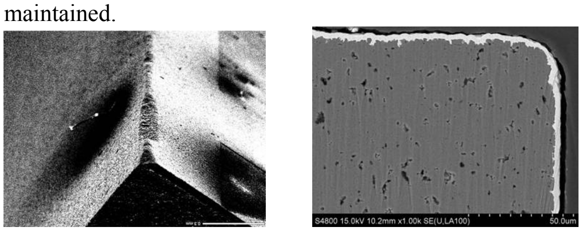
Current true edge printhead construction is as shown in the left side of figure 3. Yellow portion is common bus. There are on the both left and right side of ceramic substrate. And, new common bus construction is as shown in the right side of figure 3. Also, yellow portion is the common bus. Common bus is connected from back side of ceramic substrate through the bottom to the front side. New common bus construction has wider pattern than the current construction which is only at the both sides of ceramic substrate. Then, it makes less resistance than current one.



Current common bus New common bus construction

Figure 3. Common bus construction

To apply new common bus construction, maintenance of the electrical connection at the bottom edges of the ceramic substrate can be a problem by thin film process. Usually, thin film may be very thin or disconnected at the edge by typical thin film process like spattering or evaporation method. To avoid it, special process is applied to keep connection. Figure 4 shows the scanning electron microscope images at the bottom edge of the ceramic substrate which treated with above special process. Left picture shows overview of the edge. And, right picture shows the cross section of the edge. Light portion in the picture is conductive layer. Electrical connection at the edge of the ceramic substrate is maintained.



Overview Cross section

Figure 4. SEM picture of the ceramic substrate edge.

After this process is established, printhead sample has been developed and evaluated.

Common bus capability comparison

To compare the common bus capability between current and new common bus construction, printouts optical density comparison has been done. Using current and new construction printhead, full black pattern with 96 continuous dots and 672 continuous dots which is shown in figure 5 are printed by various applied energy. If common bus is weak which means common resistance is relatively big, power consumption in the common bus is happened. When printed dots are many, this power consumption is big. As a result, printout shows lower optical density. The other hand, if printed dots are less, printout optical density is higher. This phenomenon is very much known in thermal printing related industry. When printer is developed, this common bus power consumption may be compensated. For printing, typical gray scale thermal paper was used. And, for optical density measurement, Macbeth densitometer is used.

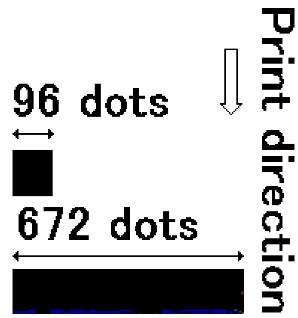


Figure 5. 96 dots and 672 dots print pattern

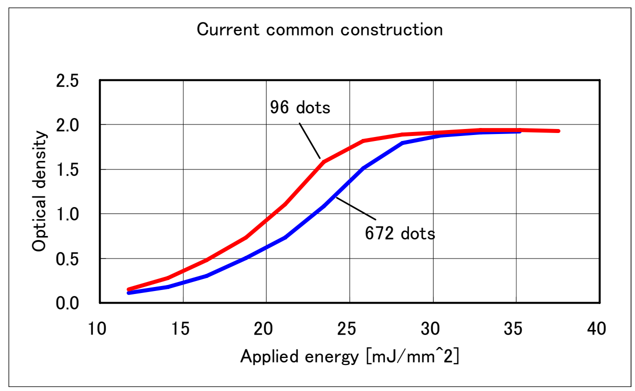


Figure 6. Optical density measurement (Current construction)

Figure 6 shows the optical density measurement result of current common bus construction. Red curve shows 96 dots printing and blue curve shows 672 dots printing. To get certain optical density, 672 dots printing require more energy than 96 dots printing.

Figure 7 shows the result of new common construction. Read and blue curve energy difference is smaller than figure 5. This

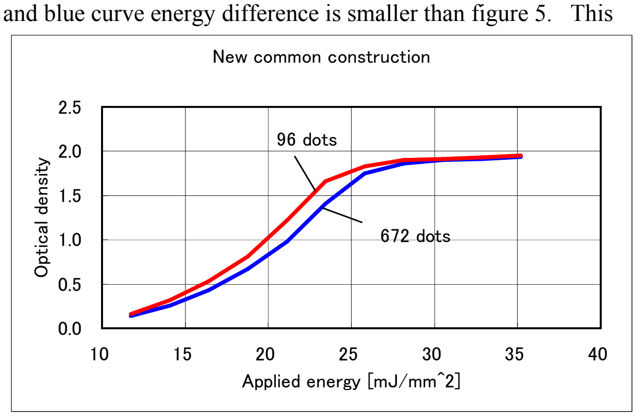


Figure 7. Optical density measurement (New construction)

result supports the new common bus construction consume less power than current construction.

Figure 8 shows the optical density difference between 96 dots and 672 dots printing for both new and current common construction printheads.

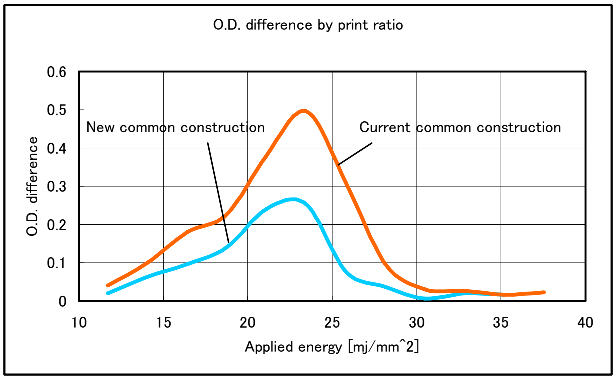


Figure 8. Optical density measurement (New construction)

From the chart in figure 8, strength of new common construction is obvious.

Real time temperature detection of ceramic

Printhead temperature goes up by printing. It is very much known. When print on card with photograph, it affect to the print quality. Especially, printing first 10mm and last 10mm shows different optical density even in a same card. Also, continuous cards printing may be also significant. Average optical density of first card and second card may not be same. To compensate it, printhead has thermistor to detect printhead temperature. Then, printer applies the temperature compensation based on thermistor temperature. However, to print faster and even current speed, those optical density differences may become a problem to keep consistent print quality. This was mostly from temperature detection of ceramic speed by thermistor. If this response becomes faster to be real time temperature detection, printer can compensate applied energy as real time compensation.

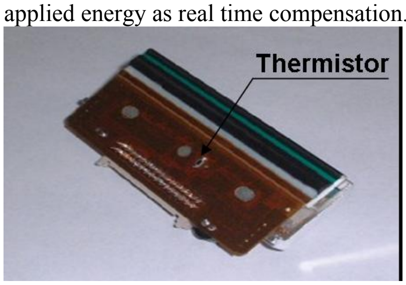


Figure 9. Printhead (Thermistor on the FPC)

Figure 9 shows the current thermistor location which is on the FPC. It detects the ceramic temperature through the heat sink. It means thermistor response isn't enough high.

Figure 10 shows the new thermistor location which is on the ceramic directly. It measures the ceramic temperature directly. It means thermistor response is higher than thermistor on the FPC.

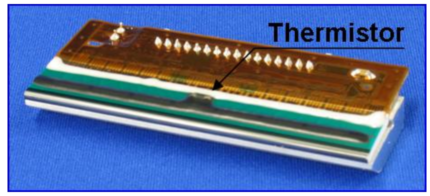


Figure 10. Printhead (Thermistor on the ceramic)

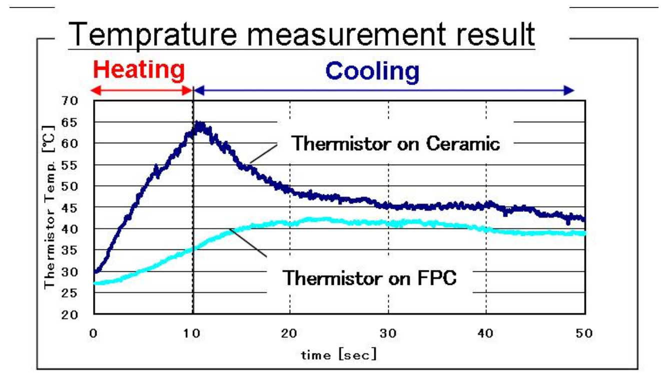


Figure 11. Temperature measurement result

temperature detection. The other hand, the result of thermistor on the ceramic shows higher temperature than the result on the FPC. And, it shows temperature goes down immediately after stop heating. So, it gives us enough response as real time temperature detection.

Higher heat dissipation construction

In a last section, thermistor response has been discussed. And, thermistor on the ceramic makes real time temperature detection possible. The other hand, physical heat dissipation is also related with the print quality. If it is slow, it can be a cause of significant heat accumulation to printhead temperature high. And, it can be a cause of print degradation by trailing on the print out which called "obiki" phenomena. In this section, physical heat dissipation construction is discussed.

Figure 12 shows the printhead construction. There is adhesive between heat sink and ceramic in the current construction. In a new construction, the portion of adhesive is replaced by heat conductive resin. Then, this resin portion gives better heat dissipation from ceramic to heat sink.

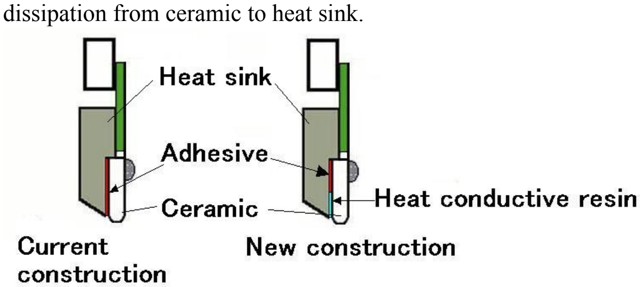


Figure 12. Heat dissipation construction

Figure 13 shows the heat accumulation test by continuous printing on the typical thermal paper. X axis shows the printout location from the beginning point as 0mm. Then, optical density goes up by printing distance. From the result, there is significant difference between current and new construction. New construction shows less optical density than current construction. This difference is from heat dissipation construction.

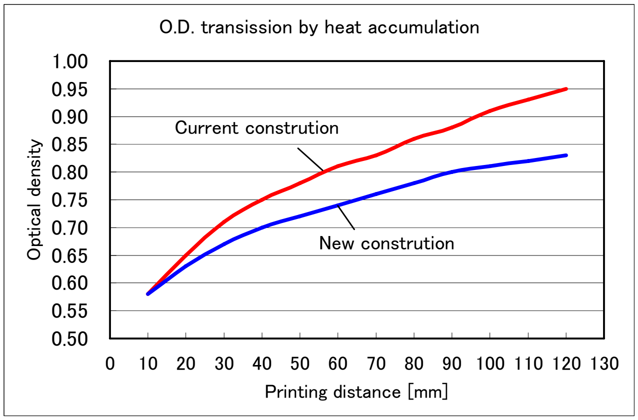


Figure 13. Printouts O.D. comparison by heat accumulation

Figure 14 shows the print on plastic card by commercial card printer. After full black printing, gray scale printing has been done. Then, "obiki" trailing can be observed in a gray printing after full black pattern of the current construction printhead. The other hand, there is no "obiki" trailing can be observed of the new construction printhead.

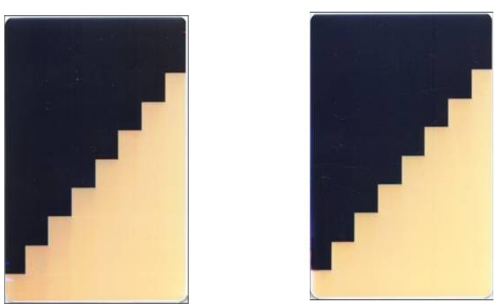


Figure 14. Gray scale printout on card

As a result, heat dissipation construction modification which replaced the portion of adhesive by heat conductive resin affect to print quality better.

Conclusion

In this paper, to make card printer printhead higher speed and quality, following items were discussed.

1. Improved common bus construction
2. Real time temperature detection of ceramic
3. Higher heat dissipation construction.

All items are improved from current construction by new construction printhead. When all of constructions are applied into the printhead, its performance as a print speed and print quality should be improved. To do so, this construction printhead will contribute to raise the printer performance in the card printer industry.

High speed and high quality for printing on the plastic card is discussed in this paper. Also, we are pursuing the high reliability and high efficiency technologies onto this true edge printhead. I hope those items will be discussed in the future paper as well.

References

[1] Hidekazu Akamatsu, Development of true edge H seires printhead (IS&T, Salt lake city UT, 2004) pg. 989.

[2] Hidekazu Akamatsu, Maximum performance of printhead (IS&T, An courage AL, 2007) pg. 142.

[3] Hidekazu, Akamatsu, Development of high speed real edge printhead for card printer (IS&T, Pittsburgh, PA, 2008) pg 829.

Author Biography

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