

# Optimization of Thermal Printhead for expanding application

Tadashi Yamamoto; ROHM Electronics U.S.A., LLC; San Diego, CA, Tadayoshi Sato, Masatoshi Nakanishi, Takaya Nagahata; ROHM CO., LTD.; Kyoto, Japan

## Abstract

In recent years, thermal printer market does not stay in only FAX or POS, but it is expanded to variety of applications especially, barcode label printer, portable printer and card printer. Barcode label printer requires the high quality print with the high speed. Step free printhead can contribute to this application.

Portable printer requires the small size / light weight and the good energy efficiency. And, card printer has some interested media, such as rewritable paper.

We would like to introduce the thermal print head technology for each thermal application.

## 1. Requirement from the markets

Recently the thermal printer market is expanding to variety of applications and each application has different requirement from the others.

For example, for barcode label printer market, there are strong demands for high speed and high print quality.

Also, for portable printer market which is expanding very much, the market strongly requires the small-size and the energy saving. And card printer, has some interested materials such as rewritable media.

Therefore, the thermal printhead is needed to adjust the function to each market requirement in order to have a good performance. I would like to explain one of the solutions for their market requirement.

## 2. Barcode label printer

The demands from the barcode label printer market are high speed print and high quality print with high reliability. The reason of high speed print is especially because of the demand increase at the logistics industry and also on-demand printing for industrial use. And the reasons of high quality print are to prevent misreading of barcodes, and rapidly increasing 2D barcode usage such as QR code.

Also, in this market, the information is read automatically by machines, not by human. Therefore, high quality with high reliability is required for this market.

### 2.1. Heat transfer

Usually when the print speed gets higher, the print quality becomes worse because the speed of the heat transfer from the printhead to the print media such as thermal paper would not be able to catch up with the print speed. Therefore improving the speed of the heat transfer is very important for high speed printing.

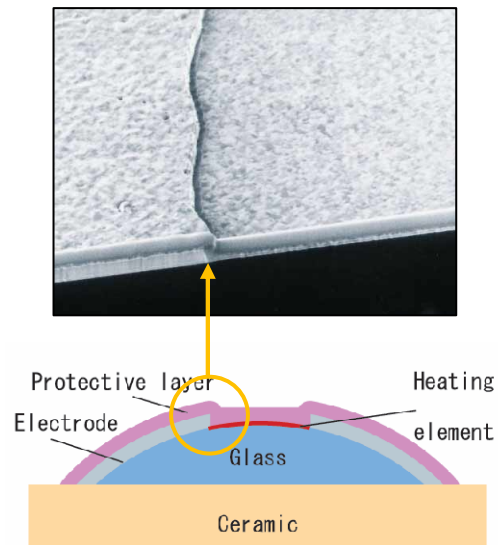


Figure 1-1. Schematic diagram of thin-film printhead

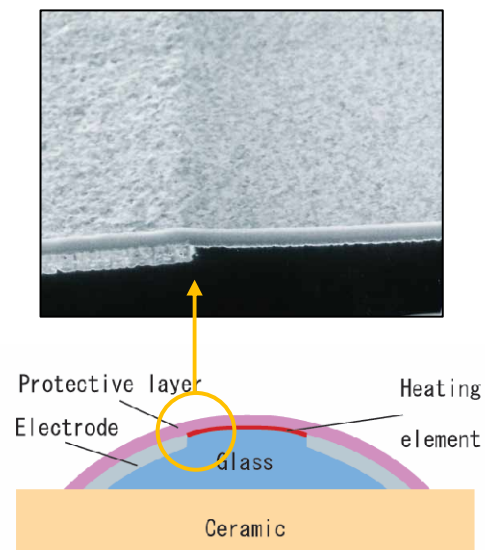


Figure 1-2. Schematic diagram of step free printhead

Fig.1-1 shows the schematic cross-section and SEM photograph of general thin-film thermal printhead. As you can see, the printhead has steps on heat element, and there is a gap between the heat element and the print media. This gap would work as heat insulation layer so we paid attention to the fact that this gap affects the heat transfer to the print media in a negative way. So the gap should be removed for high speed printing.

Fig.1-2 shows the schematic cross-section and SEM photograph of step free thermal printhead. This type of printhead has no step on the heat element. The thermal transfer with this head is better than general thin-film printhead as the printhead has the fine contact with the print media.

Fig.2-1 shows the printed results at 300mm/sec print speed of thin-film printhead. On the other hand, Fig.2-2 shows the one of step-free printhead. Obviously, step free printhead can print more clearly than thin-film printhead. The reason is that the heat transfer is improved because the gap is removed.

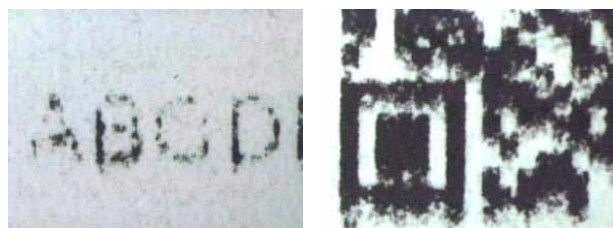


Figure 2-1. Magnified print result of thin-film printhead

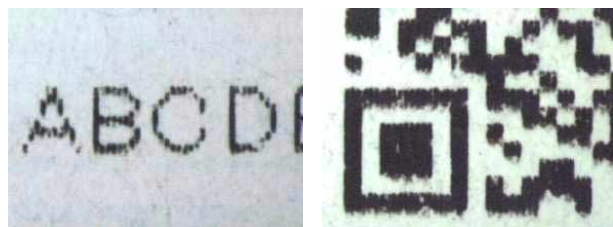


Figure 2-2. Magnified print result of step free printhead

## 2.2. Improving quality of barcode

In order to investigate the quality of barcode, we printed five kinds of barcode (two vertical barcodes; A, B and three rotate barcodes; C, D, E) at 300mm/sec print speed and measured ANSI score of them by using barcode reader with laser. Fig3-1 shows the score with general thin-film printhead. The scores of A and B barcodes are over 2.5 but the scores of C, D and E are inferior to A and B. The rotated barcode is more difficult for thermal printing than the vertical barcode because it needs very quick response of heat.

Fig.3-2 shows the scores with step free printhead. All of scores are over 2.5 even though barcode C, D and E, and we can't find any difference between the vertical and rotate barcode. As you can see in the picture of the magnified barcode D, step free printhead has the clearer print result than general thin-film printhead.

## 2.3. Possibility of high speed print

The industrial market of printer, such as the packaging printer, requires much higher print speed than 300mm/sec. In general, the historical control technology is very useful for high quality printing at high speed print. We got the print-test by combing step free printhead and the driver IC with historical control function. Fig.4 shows the print result at 800 and 1000 mm/sec print speed. As you can see, we can achieve the clear print even 1000 mm/sec, and now we are trying over 1000 mm/sec.

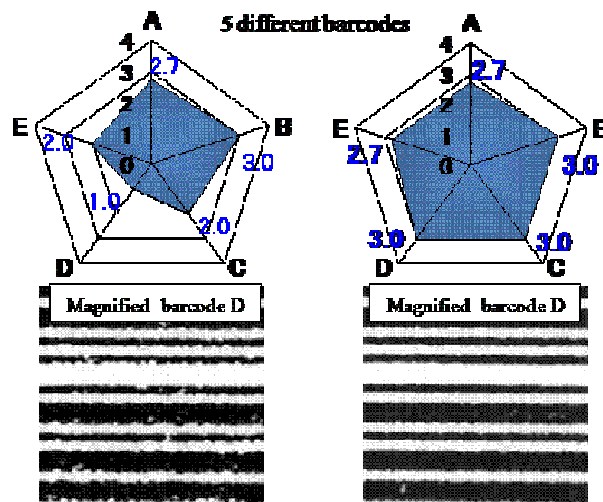


Figure 3-1 Thin-film head

Figure 3-2 Step free head

Figure 3. ANSI score and Magnified barcode D



800mm/sec

1000mm/sec

Figure 4. Magnified print result of step free printhead

## 3. Portable printer

Recently, the demand of the portable printer is increasing in various situations such as credit card terminal, receipt printer and industrial printer. It is very important to carry the printer easily so the market requires small size / light weight and energy saving for long battery life.

### 3.1. Small size and Light weight

Our original printhead for this application has 14mm ceramic width and around 4g weight. Now we have smaller and lighter printhead which has 10mm ceramic width and around 3g weight. And we are developing next generation of printhead for portable application, and the printhead has less than 8mm ceramic width and around 2g weight.

### 3.2. Improving energy efficiency

Generally, the thick-film thermal printhead has around 0.2mm width heat element as 200dpi resolution. This printhead

can create a dot by just one time print as shown Fig.5-1. In the middle of this figure, the surface temperature distribution of heat element is shown. This is in the condition of continuous 3dots fired. The temperature at the center of heat element is around 330 degree.

Regarding the energy efficiency, narrower heat element is useful but this printhead needs twice the printing for one dot. However by minimizing the size of heat element contributes to higher energy efficiency by concentrating the thermal energy generated by heat element. Fig.5-2 shows the magnified heat

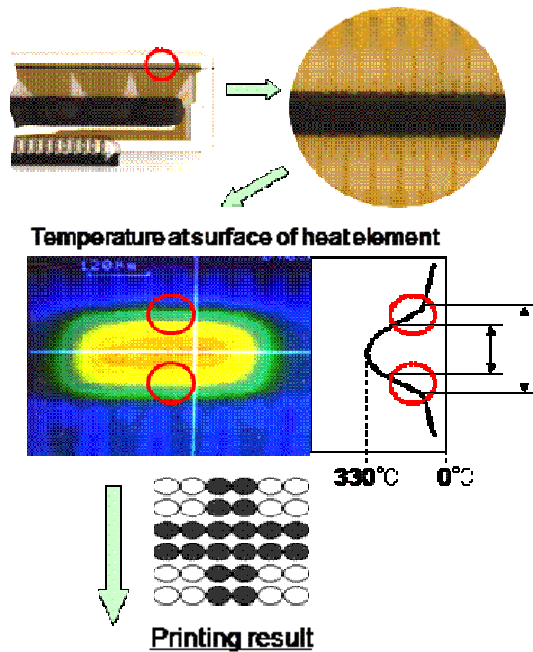


Figure 5-1. Magnified heat element and surface temperature of general thick-film printhead

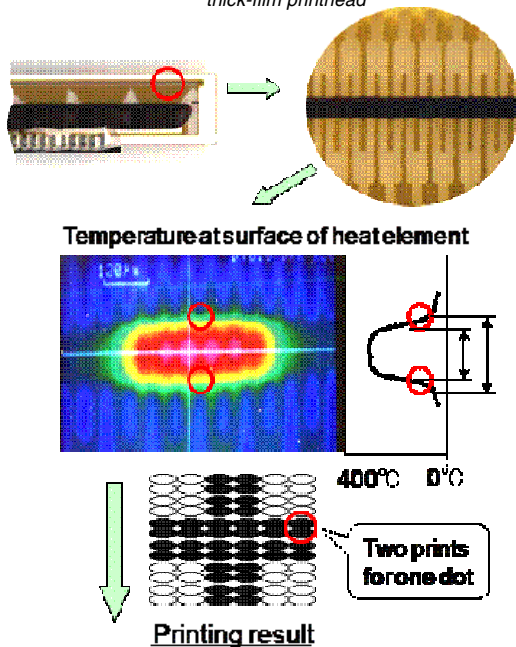


Figure 5-2. Magnified heat element and surface temperature of thick-film printhead with narrower heat element

element and the surface temperature of this type printhead in the same condition as the previous one. Actually the temperature at surface of the heat element is around 400 degree and it is higher than general structure.

Fig.6 shows the relation between the supply energy and the optical density. The dot line shows our conventional thick-film printhead. On the other hand, the continuous line shows our new type printhead which has narrower heat element and thicker glaze. At the point achieved 1.2 optical density, this printhead has around 30% better energy efficiency compared to our conventional printhead.

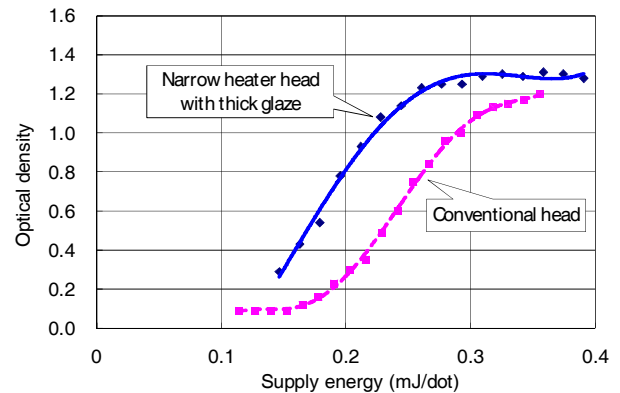


Figure 6. Magnified print result of step free printhead

#### 4. Desktop printer

So far, desktop printer, such as POS printer, is operated by 5V logic voltage but it recently is coming to be operated by 3.3V logic voltage to suit any other electrical devices. Fig.7 shows the schematic chart of the relation between logic voltage (VDD) and output resistance of the driver IC (Ron) in thermal printhead. In general, the smaller VDD is, the bigger Ron is like dot line. That means the optical density of print result becomes lower at VDD 3.3V compared to 5V. We developed the driver IC with new technology which has the stable Ron like a continuous line in order to keep the same printing result regardless of VDD.

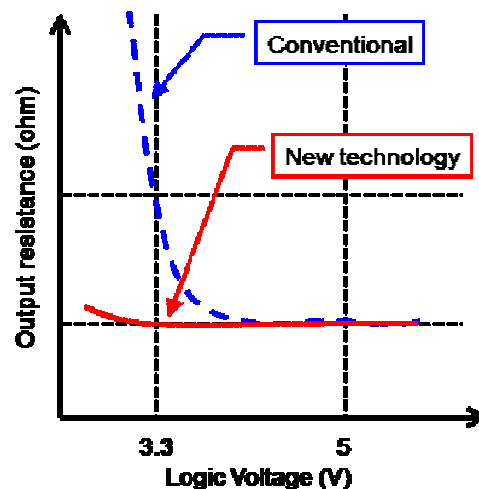


Figure 7. Schematic chart of relationship between VDD and Ron

Fig.8 is the graph shows the relationship between supply energy and optical density. The dot line is VDD 5V, the continuous line is VDD 3.3V. As you can see, optical density of 5V and 3.3V are the same.

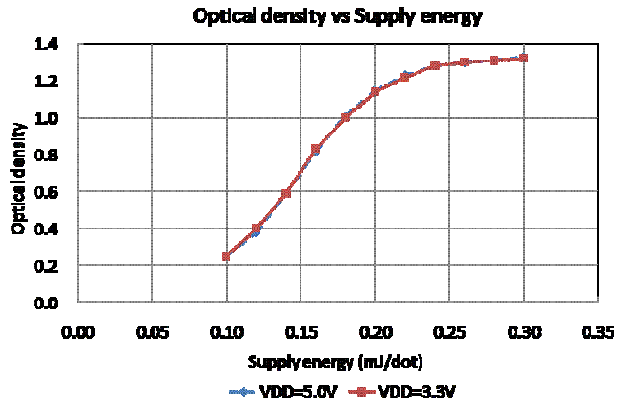


Figure 8. Magnified print result of step free printhead

## 5. Card printer

Recently the card printer is expanding in various applications. In them, rewritable card is particularly interesting. Rewritable cards can be printed and erased by controlling their temperature. Generally, the thermal printhead is used for printing, and the heater bar or something like that is used for erasing. In erasing use, the eraser is needed to have the good contact with the card in order to erase anything clearly.

Step free printhead has better contact with card than general



Figure 9-1. Print result of rewritable card with step free head

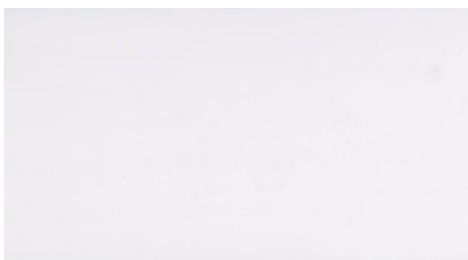


Figure 9-2. Erase result of rewritable card with step free head

printhead and so this printhead has possibility of erasing ability.

We tested printing and erasing by using only one step free head. Fig.6-1 shows the printing result and Fig.6-2 shows the erasing result. According to the result, step free printhead has an enough ability of erasing because this head has very flat surface at heat element and it makes the contact with the card better.

## 6. Conclusion

Thermal print market is expanded to various applications and so each market requires the different function or specification. The movement is expected to continue in future. Also, the thermal print market is spread to whole of the world as well and each region has different demands. Therefore it is important to adjust thermal printhead technology to each requirement.

In this paper, we mentioned that step free technology is very useful for high speed printer and card printer because it makes good contact between the printhead and the print media, and it makes it possible that the printing results are clearly. As for portable printer, its market is especially expanded. The thick-film printhead with narrow heat element is useful.

## Author Biography

Tadashi Yamamoto received his B.A. in engineering from the Osaka University (1998) and his M.A. in applied engineering from Osaka University (2000). Since then he has worked in the Printhead Division at ROHM CO., LTD in Kyoto, Japan. His work has focused on the development of thermal print head. Now he works at ROHM Electronics U.S.A., LLC in San Diego, CA.