Thin Film Heads for Thermal Printers in 2004

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Abstract

The most common market segments for thermal printers are bar code, point of sale and card printers. They require the head to print on three types of media: thermal paper, thermal transfer ribbon and dye transfer ribbon. In the emerging market segments there are additional demands made by photographic quality printing, wide format and medical printers. These new markets make specialized print quality demands of the head and utilize new types of media. However, these new print media have served to widen the base of markets served by thermal printing. At the same time that heads are required to print on these new media types with increased performance, the traditional demands of the electronics industry still provide constant downward price pressure.

The resistor overcoat must survive chemical attacks from an array of standard and new media, resist abrasion from the same media variety and also are thin enough to transmit heat to the media in an efficient manner. When the circumstances require, the overcoat should also provide a strong defense against electrostatic discharge.

So this paper is a presentation on the latest heads designed for printers in five of these specific markets and the overcoats that are applied for the protection of the resistors in those applications. The development of lower cost heads, while simultaneously increasing capability is also described.

Introduction

Designing with thermal printheads serves as a kind of fourth dimensional challenge to those engineers working to design new thermal printers. All engineers work with mechanical, electronic and software considerations. Thermal printer engineers, however have an overlay of thermal management beyond the needs of removing heat to provide for the safety of components and subsystems. They must utilize the thermal print head to 1) Generate sufficient heat to activate their particular media. 2) Provide sufficient heat to meet the system print speed specification 3) Maintain a temperature which does not cause premature resistor failure. An additional requirement for precise heat accumulation is added if the output will be gray scale, which is the case of medical X-ray printers or consumer photographic printers. The generation, control and dissipation of the heat in the head must be managed with great sophistication.

Thermal Printer Market Segments

The following table includes estimates of market share and ranking according to dollar sales for all thermal printers. Subsequent paragraphs will describe print heads designed for segments identified by number in the table below.

Thermal Print Head Market Segments

Segment	Percent
1. Barcode	39.3
Fax	13.5
3. Card	10.1
4. Photographic Color (Consumer)	7.2
2. Point of Sale	5.9
5. Medical Film	5.0
Chart	3.4
1. Ticket	2.9
Postage	2.6
Stencil	2.5
Tape	2.5
Color (Industrial)	2.2
Battery	1.5
Others	0.4
Wide format	0.3

1. Bar Code and Ticket Printer Heads

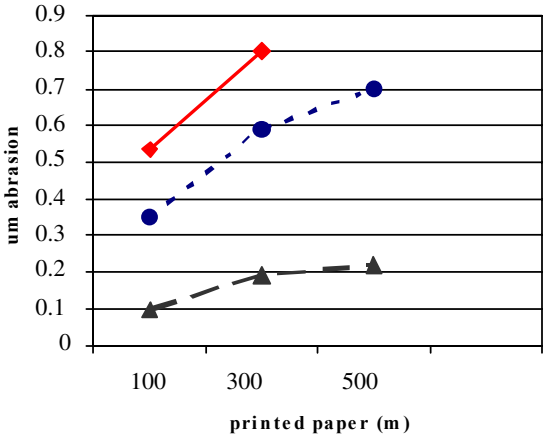
These printers require heads of 200 or 300 dots per inch with print speeds of 10 inches per second or more. One answer to these market demands is the KPC design, below:

	Present KPC	New KPC Series
Data-In	1	1 to 3
Print Speed	6 ips	10 ips
R- Average	800 ohms +/- 10%	600 ohms +/- 10%
Platen Dia.	20 mm max.	20 mm max.

The newest ICs in these heads permit greater precision in controlling print dot characteristics, as a result of the heat accumulated. Moreover this head has excellent compatibility with a 300 dots per inch version, thus easing the design of a printer series.

Recent improvements in direct thermal media have resulted in greater utilization of thermal paper, now dominating the ticket market and controlling a major share of bar code label market. Since thermal paper causes more wear than thermal ribbon, this places increasing demands on the printhead to resist abrasion, particularly since the typical print speed has approximately doubled in the past five years.

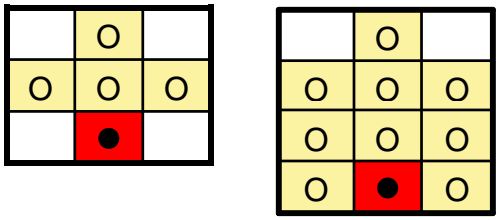
Wear Characteristics of Three Materials



The solid curve on the above graph represents the resistor overcoat protective wear material traditionally used for bar code applications and the curve with short dashes shows the material traditionally used for coarser media, such as theatre tickets. The newest material, shown in the curve lowest on the graph, has a wear rate less than 30% of the previous best one.

For lower speed (six inches per second) and lower priced printers, a second new printhead series, the KPB series is announced. The series is made possible by a new IC driver, which has higher current capability, permitting an average resistance of 900 ohms, compared to the previous 1,500 ohms and offers a 3.3V logic voltage.

Traditionally in the United States, the larger bar code printer manufacturers have preferred to determine their own history control paradigm usually based on a custom set of variables for each printer mechanism. Occasionally in the interests of time to market or companies with limited engineering resources prefer to buy a head with an included standard history control algorithm. A new method is shown here on the right:



The print dot being controlled is at the center bottom of each table. Circles indicate the dots, whose print history is being used to determine the energy to be applied. The additional history permits fifteen inch per second print speed without "trailing" (the inadvertent darkening of thermal paper, sluicing past a resistor still hot enough to accidentally activate the paper.) The clock frequency of the IC is 8 MHz to 12 MHz.

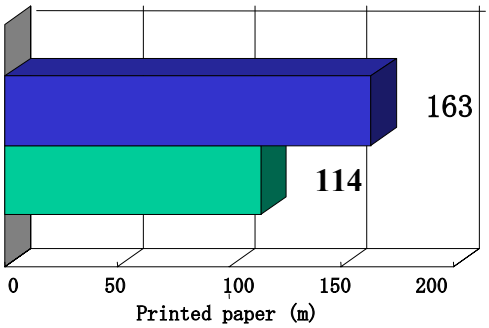
2. Point of Sale Printer Heads

This market traditionally has adopted specifications similar to bar code label and ticket printheads with additional features, which customize it for POS applications. However, the retail environment has been requesting these new features for receipt printers: 1) Higher print speeds, up to six inches per second at aggressive prices. 2) Two color printing in some cases. And an additional requirement is for those POS printers used in mobile printers for reduced battery consumption.

The conventional head design has had a separate area for driver IC locations and soldering the flexible printed circuit. The new KPB and KPC designs each feature shorter ICs, allowing for intermittent spacing of the flex circuit contacts between them, thus permitting a narrower ceramic substrate and greater manufacturing throughput. This is what allows the drop in prices at the same time as a doubling of print speed from three inches per second to six inches per second.

A new higher efficiency head for mobile applications provides a 20% improvement in thermal efficiency. This is obtained, through a new glaze structure, which provides more intimate contact with the print media. On the graph below, the increase in battery life is shown as a 43% increase in the amount of thermal paper printed.

Increase in Battery Life

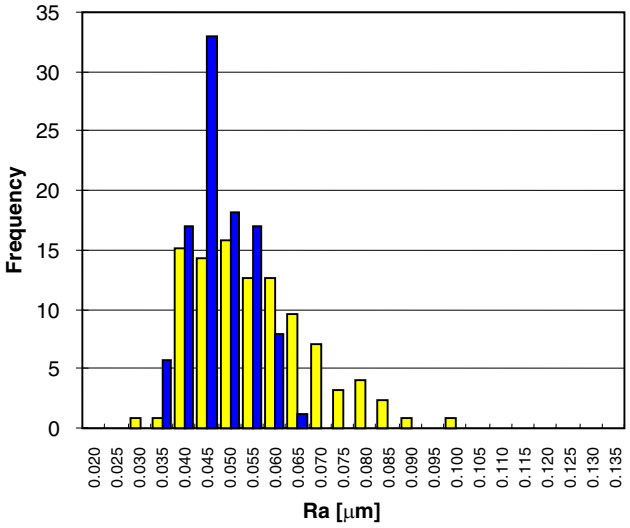


The new two color thermal paper for POS has presented a challenge to accurately produce each color at a desired print speed without inadvertent shading from the contrasting color. The new KPA-80-8MTA1 was able to perform with that level of precise color rendition at a print speed of three inches per second without any history control.

3. Printer Heads for the Card Market

The uses of card printers are finding increased utilization for secure photo ID badges, transportation cards, monochrome photo ID cards and rewritable loyalty cards, all in the present atmosphere of aggressive cost reduction. For more than five years now, Kyocera's KDE series has been the Gold Standard with a more than 90% market share in card printer applications. The KEE series supplanted it in production printers which began production in 2002. Now the KGE Series is introduced. It is 20% smaller than KEE and 40% smaller than KDE. It has a surface common bus and 4000 ohms average resistance and a simplified design with a simplified one row connector, instead of two. The improvement in operating characteristics which has been recently applied to the KDE and KEE series' is also available in the KGE series, even though each one is priced successively lower.

Resistor Surface Smoothness

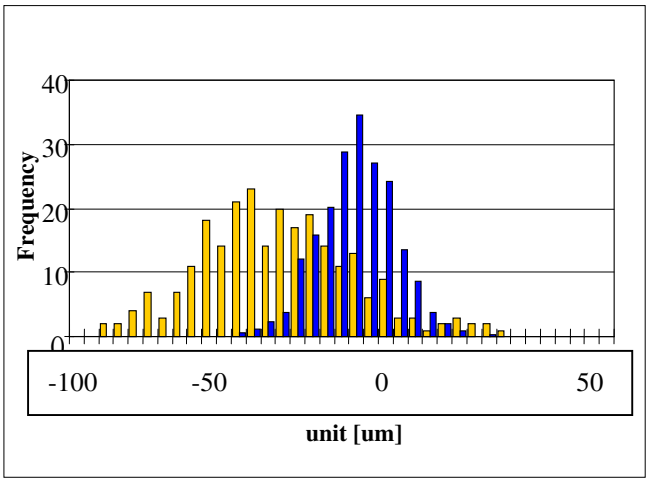


Surface smoothness of the heater line is paramount in gray scale printing with dye transfer ribbons, which are sensitive to pressure as well as heat variations. The dark bars in the above graph show the improved smoothness of recently implemented processes for the KGE and also older designs.

Heater Position

Time of assembly of card printers is enhanced by improving the location of the heater line closer to the normal of the curve formed by the glaze area. The heater position graph (dark lines) below shows the significant strides made in this area, since November of 2001 as the distribution of the heater line location around the ideal location, approaches a tight bell shaped distribution, compared to previous results.

Resister Position

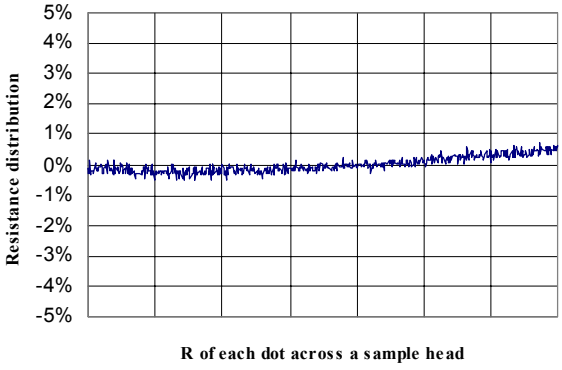


4. Printheads for Photo Quality Printers

Thermal heads are now utilized in photo printers in kiosks and consumer photo printers, operated by personal computers or digital cameras. This application requires 1) Advanced control of resistance with the goal to maximize optical density. 2) Unique and customized glaze construction options to maximize thermal response and match it with particular media 3) Extraordinarily smooth glaze to reduce granularity and maximize image quality 4) Reliability to eliminate service calls.

Surface smoothness of the heater line shown in the preceding graph, in the section on card printing, applies equally to photographic printers. The AD process described below is a process that has been applied for more than five years, but is reviewed here, as an introduction to the GAD process, the MD process and the PA process, all developed in 2002 for introduction this year.

AD Process Impact on Resistance Profile

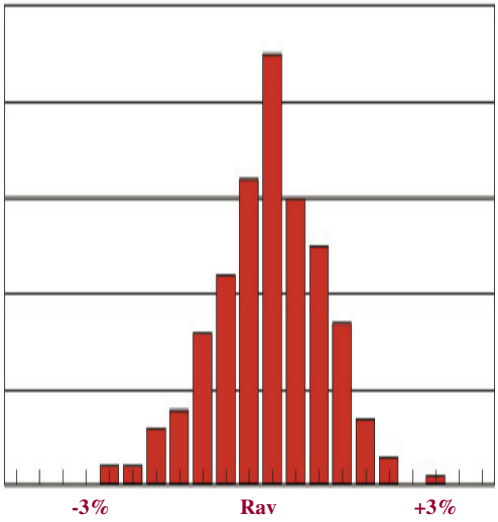


The AD process controls resistor values, which can typically range from +10% to – 15% to a range of 2 to 3% with a much closer resistance change between any two adjacent dots The purpose of the process is to prevent optical density variations in photographs caused by resistance variation from 1.0 to 1.5%.

GAD Process

This is a process applied in addition to the AD process. It permits the printer to greatly reduce artifacts and enhance gray scales by diminishing minor dot to dot resistance variation across the head.

MD Process



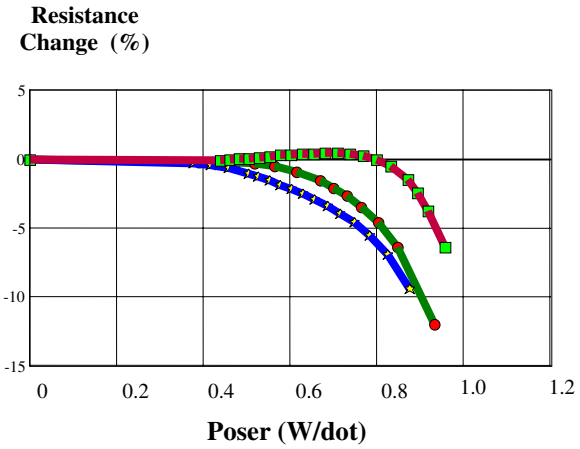
The MD process performs a trimming of resistance values so that the average resistance of all heads within a lot and from lot to lot for a given printer is within a range of +/- 3%.

PA Process

The last newly developed process for photographic print heads to be discussed here, is applied to gray scale heads for the purpose of increased durability of the resistors to electrical break down. The example data in the upper curve of the graph was developed from a head model KPA-104-8MTA2, using these print conditions: P=0.6W/dot, Tcy=0.833ms, Ton=0.40ms.

The graph is an accelerated life test in which resistance decline is associated with approaching the end of head life. The data shown, applies only to this part number and set of printing conditions. Each new print head part number and modification in printing conditions will have different results.

Step Stress Test following PA Process



5. Thermal Heads for Medical Printers

The need for medical facilities to have convenient desktop printers, which can easily print digital medical images on films has driven the development of replacements for traditional X-ray film processes. This market is growing rapidly, as medical facilities can eliminate the expense and concerns of chemical waste disposal and also add the convenience of digital storage and retrieval of patient information.

Kyocera typically designs custom heads for each manufacturer in this industry. The features required by these heads are:

1. High resolution capability (up to 660 dots / inch)
2. Low cost designs in 300 or 320 dots / inch)
3. Exceptionally smooth glaze surface.
4. Protective overcoats to match the particular film characteristics.

Biography

Richard Collins received his B.A. degree from Youngstown State University in Youngstown, Ohio in 1963 and his MBA from The University of Denver in 1971. He has worked as a Product Specialist at Kyocera International, Inc. before becoming one of the founding team at Kyocera Industrial Ceramics Corporation and currently serves as Vice President Sales, I/O Devices Group, responsible for LCDs, thermal and LED printheads and amorphous silicon drums throughout North America.