After Conquering Retail, Thermal Printers Moving into Handheld Market

Rohm Electronics

Having largely captured the bulk of the custom retail and industrial printer market, thermal printers are making a big play for the handheld market. Thermal printers now dominate the fax, point-of-sale, bar-code, label and ticket markets because of their low-cost, excellent print quality, lack of noise and ease of integration. Yet, portable printer manufacturers have been crying out for lower-energy, lighter-weight and smaller-size thermal printheads to help them increase the size of their market. Recent advancements, particularly new finer heating elements that require less power, have paved the way for a rapid expansion of this market. In an encouraging sign, hand-held thermal printers are already used to produce all of the tickets sold on Japanese bullet trains.

While more expensive technologies such as dot matrix and laser have largely captured the attention of the public, thermal printers have silently moved into a position of dominance in a wide range of markets where their low-cost and simple operation are more important than the super high resolution printing capabilities of inkjet and laser printers. Three years ago, the chances are great that when you ate a restaurant meal your receipt would be printed on a dot matrix printer. Today, it's almost certain to be printed on a thermal printer. Likewise thermal printers have captured the vast majority of the fax market, including even many high end faxes which use thermal transfer printers to produce an image on plain paper. Along with their penetration of the point-of-sale market, thermal printers have achieved a strong market position in producing a wide range of labels, tickets, kiosk printouts and the majority of all other custom printing applications.

Two different technologies

The field of thermal printing actually comprises two related but different technologies. Direct thermal printing, used on low-end fax machines for example, uses special treated paper that darkens when heated by the printhead. Thermal transfer printers, on the other hand, use a coated ribbon to transfer the image to a wide range of printing materials including plain paper. The heart of both devices is in the thermal printhead, which provides the energy necessary to form the image. The "line-type" printhead (as opposed to moving or "serial-type" printhead) does not require a scanning mechanism, resulting in a very simple and inexpensive device. Yet because print element position is fixed normal to the web motion direction, excellent print accuracy can be achieved. The relative location of print element spacing on thermal printheads is often held to tolerances as small as 0.0001 inch.

To create an image, a processor determines the individual resistive printhead elements that will be selectively heated as the media is moved past the printhead. The image is built from a matrix of individual dots by alternating the movement of the media and selective heating on the dots. In direct thermal printing, the image is produced when the dye in the coating of the paper is activated by heat. This eliminates the need for a ribbon. In thermal transfer printing, on the other hand,

heat is supplied by the printhead to a thermal transfer ribbon that has a media such as paper under the inked side of the ribbon. The heat supplied by the printhead melts the wax or resin that contains the ink, allowing it to transfer to the receiving media, where it cools and becomes solidified.

Advantages of thermal printing

Why have thermal printers achieved such a heavy market penetration in the last several years? One important reason is the simplicity of this technology. Unlike a laser printer, fuser and toner is not required. Direct thermal printing is the most compact of any printing technology because all that is needed is a printhead, media and some method of moving the media. This simplicity is also responsible for making thermal printing the least expensive printing technology by a considerable margin. The lack of any moving parts makes thermal printers extremely reliable and durable. Thermal printing is also capable of achieving speeds of 10 inches per second, considerably faster than the typical dot matrix printer with in the comparable level because the dot matrix head needs to move back and forth across the width of the paper like a typewriter.

Print quality is crucial in many applications and this is another area where thermal printing is very strong. The resolution of thermal printers typically varies from 203 to 300 dots per inch, substantially better than dot matrix. Almost all commonly used printing materials can be printed with a thermal transfer printer including paper, polyester, vinyl and specially constructed high temperature resistant polymer films. But several disadvantages of thermal printing should also be noted. Print speed, while fast, is limited by the heating and cooling of the printhead. Direct thermal printers require the use of special papers that have a tendency to darken if they are exposed to extreme heat after printing. Some thermal transfer images also can be scraped off when rubbed or scratched with a hard object. This is because the wax or resin, which contains the ink used in a thermal ribbon, is melted onto the receiving media surface and not &quotdiffused&quot into the material.

Multiple manufacturing technologies

Despite the simplicity and low-cost of a thermal printhead, a surprisingly large number of technologies are involved in its manufacture. One important requirement is the ability to produce the resistors that comprise the heating elements to a very high level of accuracy. Either thick-film or thin-film technology may be used depending on the required design and composition of the heating elements. The most capable printhead manufacturers offer a wide range of products including both of these basic as well as hybrid technologies. Large scale integration manufacturing technology is required to fine-tune the driver integrated circuit to maximize the printhead capability. Assembly technology also plays a critical role, such the ability to produce 50 micrometer pitch wire bonds in order to create over 2000 wires in an eight inch printhead.

Several major advances have played a major role in the increasing market penetration of thermal printers in the recent years. One of the more important is a simplification of the printhead structure that eliminates many components, reducing the cost and delivery lead time of the head. Printheads were traditionally made using a flexible cable that, although it eliminated the need to solder individual wires to the ceramic head, also hindered simplification and size reduction efforts because of the complicated hardware required to attach it. This problem was overcome with the development of a new connector that clips to the ceramic substrate, using spring tension to make the electrical connection. This eliminates the need for the

flexible cable, the mechanism to sandwich it with the ceramic substrate and printed circuit board used to previously make the connection. It also enables the heat sink to be separated from the head, greatly increasing design flexibility. The net result is a substantial reduction in the number of parts as well as the size and weight of the printhead.

Heating history

Another major advancement is the ability of leading-edge thermal printheads to consider the previous state of each heating element in raising its temperature to the level required for printing. Heat history becomes more important as printing speed rises because heating elements no longer have the time to cool to room temperature from one firing to the next. The new generation of printheads considers the previous lines of printing to determine the amount of heat remaining in each element as well as the heat transfer by the adjacent elements. This information is used to adjust the time used to energize the heating element. The heat applied to the element can be adjusted at six different levels in order to take these factors into account. The result is faster printing, because heating time is often reduced, lower energy requirements, more uniform print density and longer printhead life.

A thermal printhead is sometimes required to print on a flat plane without bending the print media. The traditional approach to this issue involved using an end face or edge of the substrate that placed heating elements in a vertical orientation to the normal electrode plane which consists of the driver integrated circuit mounting surface. This approach was effective but required a special production process that escalated the cost of these heads far above normal. A new style of thermal printhead is able to meet the needs of this application at a much lower cost. It incorporates a heating element at the near edge of the ceramic substrate and utilizes the curvature of its glazed structure to allow the printing medium to pass. The key advantage of the new design is that it is produced on the same equipment and using nearly identical methods to conventional flat thermal printheads. The result is a cost equivalent to conventional printheads and much lower than heads designed for flat plane printing.

Portable printing developments

Perhaps the most interesting of all the recent innovations is one that came in response to requests from portable printer manufacturers. Despite the fact that direct thermal printheads were already by far the smallest and lightest available, the portable printer manufacturers needed a substantial reduction in energy consumption, lower voltage operation and additional size and weight reduction in order to increase market penetration. The response was a new line-type heating element that is more efficient because it heats a much smaller area than a conventional heating element with special type of partial glaze. The width of the new heating elements is only about half that of conventional elements. The result is that 30% less energy is required to achieve the same optical density as a conventional heating element.

The result is a new generation of compact, low voltage, and thick-film thermal printheads that are perfectly suited for point-of-sale terminals and other types of portable printers. The new printheads offer an operating voltage as low as 2.7 V, compared to a typical operating voltage of 7.2 V. This reduction allows sufficient operating margin to enable operation by a 3.6 V lithium-ion battery. The low operating voltage also allows the printer to be powered by two conventional 1.5 V

batteries. In addition, a new FFC-compatible connector has been developed that helps reduce the overall size of the printhead by 30%. All printhead functions are incorporated into a single ceramic substrate to reduce overall size of the unit. These new printheads have proven extremely popular in a wide range of portable printing applications and have already demonstrated the ability to expand the size of the portable printer market.

While most of the attention has gone to laser and inkjet printing technologies, thermal printers have come out of nowhere to establish a strong lead in the custom printing market. The key to their success is their low cost, simple operation, long life, fast speed and high printing quality. A series of innovations over the last several years have the potential to dramatically extend the lead of thermal printers in a wide range of applications. For example, the development of new printheads optimized for the portable printer market can be expected to lead to a dramatic increase in the market for these devices by enabling the development of smaller printers that use less power. There are more innovative products on the horizon to meet the market requirements. Clearly, the successful market run of thermal printers has just begun.

For more information, visit Rohm's web site at www.rohmelectronics.com.