



Thermal Transfer vs. Direct Thermal: Five Key Considerations

BY SATO America

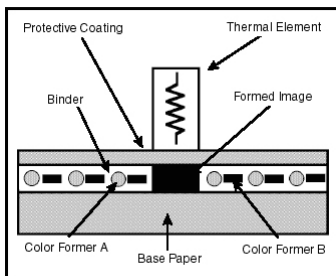
Direct thermal label printing has traditionally been a niche technology used across several narrow vertical markets including meat, poultry and dairy. However, developments in thermal paper technology have resulted in a broader range of products that are now suitable for use in many applications across nearly any vertical market. The result has been increased interest in direct thermal as the technology choice for new or upgraded applications.

First, what's the basic difference between direct thermal printing and thermal transfer printing? In simplest terms, thermal transfer printing utilizes a thermal ribbon and direct thermal printing does not. Thermal transfer involves the thermal printhead elements (dots) heating the backside of a thermal transfer ribbon to melt and transfer the compounds on the front side of the ribbon to the label material, thus creating the printed image. Direct thermal printing requires a heat sensitive label material. The printhead elements come into direct contact with the heat sensitive material where the heat from the elements causes a color change in the material to create the printed image. Of course, there is a great deal of science and technology that makes both technologies work effectively, but that detail is well beyond the scope of this paper.

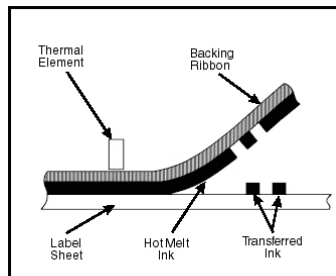
Knowing the difference between thermal transfer printing and direct thermal printing is only the first step in evaluating the two alternative technologies for use in a company's label printing application. The following considerations, while not an exhaustive list, account for the key areas of review during the technology evaluation stage.

THERMAL PRINTHEAD LIFE & COST

From the above comparison, note that direct thermal printing requires the printhead elements be in direct contact with the label material as it is pulled across the printhead. Conversely, thermal transfer printing has thermal ribbon acting as a "buffer" between the printhead elements and the label material. Many thermal ribbons are designed with a back-coating that serves to increase printhead life by reducing static and friction. This benefit is not possible when direct thermal printing due to the lack of ribbon. Instead, the label material is in direct and constant contact with the printhead, resulting in increased wear when compared to thermal transfer printing. Also in direct thermal applications, dust and debris that may become present on labels are in direct contact with the printhead. As these foreign materials are pulled across the printhead, they may burn onto the elements or physically damage the elements resulting in poor print quality and/or premature printhead failure. Certainly, the same foreign material can exist in thermal transfer printing applications. However, the debris would be between the label and the ribbon (i.e. not in contact with the printhead elements) reducing the potential for damage.



Direct Thermal Printing



Thermal Transfer Printing



Due to the situations described above, expected printhead life in direct thermal printing applications is significantly reduced when compared to thermal transfer printing applications. Generally speaking, a company should anticipate direct thermal printheads providing an expected lifetime of 25% - 50% of a thermal transfer printhead. As an example, if a company is printing 10 million, six inch long labels per period with an expected thermal transfer printhead life of 4 million inches, they would expect to replace the printhead 15 times. If the same application were direct thermal, they would expect to replace the printhead 30 – 60 times. Depending upon throughput volumes, the cost differential may be significant and has to be considered in any evaluation.

PRINTER CONFIGURATION & COST

Printer configuration is one area where some cost savings will be available. Thermal transfer printers normally have the capability of printing either thermal transfer or direct thermal. If an organization is only going to print direct thermal, there are printers available that only have direct thermal capability. These printers are generally less costly to purchase because they do not contain any of the hardware necessary for driving and controlling ribbon.

Eliminating the ribbon and ribbon hardware components also results in a less complex printer with fewer parts to wear and/or break, resulting in lower service costs and less downtime over the life of the printer. Additionally, operators don't have to be concerned with ribbon settings or adjustments, leading to improved uptime and increased efficiency.

The process of changing thermal ribbon requires downtime. Even the best operator still needs several minutes to replace used ribbon with a new roll. This is downtime, and downtime costs money. A standard size, 450 meter roll of ribbon will provide about 2,800 six-inch labels. If running 20 products per minute, for example, calculate into the evaluation several minutes of downtime about every 2.5 hours. Doesn't seem like much? If calculated at 20 hours per day average production, the result over one year would be 144 hours of downtime for ribbon changes.

MEDIA SELECTION & COST

The specific type of direct thermal media used is often the least considered aspect of most evaluations, but likely the most important. Not only will a company's media choice directly impact the cost of labels, it will also impact the life of the printhead, upper-end print speed capabilities and print quality. These are important considerations as they may impact the ongoing cost of operations.

As noted above, printhead and label are in direct contact with one another during the printing process. Therefore, the media acts as a direct abrasive as it is pulled across the printhead. If the labels are too abrasive, they will prematurely wear out the printhead resulting in increased replacement costs. Many believe

the use of a "coated" direct thermal label is a better solution than an "un-coated" label. It may be, but don't depend simply on the description that a direct thermal label is "coated" to mean it's a good label. Inferior labels can be coated the same as any other label. Therefore, a "coated" label doesn't necessarily mean it will outperform a non-coated label. There's no getting away from the label abrading the printhead, but choice of media can make a huge difference in the frequency of printhead replacement.

Also, different labels will image at different temperatures resulting in varying quality of print at different printer speed and heat settings. Choose media that can image at the printer speeds necessary to meet the production line's throughput requirements while minimizing the printer's heat setting. At the same time, print quality must be considered. Poor print quality can lead to un-scannable barcodes resulting in supply chain inefficiency and retailer charge-backs. Reputable label converters should have considerable experience with a variety of direct thermal label materials and should be able to provide several good suggestions as a starting point for media testing.

When comparing the direct costs associated with media selection, one has to compare the cost of thermal transfer labels plus thermal transfer ribbon with the cost of direct thermal media. Eliminating the use of ribbon obviously eliminates the cost associated with the ribbon. However, the higher cost of direct thermal labels over thermal transfer labels generally wipes out that savings and then some. Media costs are all over the board depending upon the actual media selected, the label size and the volumes purchased. As a general rule, direct thermal labels will cost more than thermal transfer labels plus ribbon. However, the cost differential can be as low as 5% or as high as 50% depending upon the factors cited above.

LABEL LIFE REQUIREMENTS

Requirements surrounding label life get back to the heart of the difference between direct thermal labels and thermal transfer labels...direct thermal printed labels simply do not offer the same lifetime as a thermal transfer printed label. An organization must know its label life requirements before considering direct thermal labels.

If the product being labeled could be in the supply chain for an extended period of time or in extreme conditions such as direct sunlight or chemical contact, then the technology used should likely be thermal transfer. For example, building materials are often transported unprotected and stored outdoors. Not a good choice for direct thermal technology. Another consideration would be if the information on the label is extremely critical and must be readable for an indeterminate amount of time. Examples might include pharmaceutical products or hazardous materials. These items should likely utilize thermal transfer printed labels to ensure a long lifetime.



Conversely, if the product has a short life in the supply chain and is not exposed to harsh environmental conditions, then direct thermal may very well be a good choice. Examples of this type product could include fresh meat, dairy products and shipped parcels. Regulatory requirements for privacy of information are another area impacting the use of direct thermal media. In healthcare, patient privacy can be at risk if personal information is available on used thermal transfer ribbon. This has led to an increased use of direct thermal media for prescription labels and patient wristbands, for example.

ENVIRONMENTAL CONSIDERATIONS

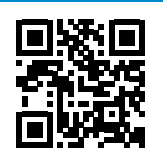
Five years ago, this category would not have been considered critically important. However, in today's world of reduced carbon footprints, waste reduction and sustainability, it has become quite important for many organizations. Waste reduction and lower carbon footprints are increasingly part of corporate mission statements and, in some cases, used to increase competitive advantage. Thermal ribbon uses a poly-based carrier made, in part, from crude oil products. Eliminating the use of thermal transfer ribbon can therefore positively impact a company's goal for a reduced carbon footprint. When using ribbon, the spent ribbon and cores must be disposed of, adding to a company's waste

stream. Direct thermal technology eliminates the use of thermal ribbons and therefore eliminates the waste created through its use.

As advances in direct thermal materials continue to expand the potential use applications, the above considerations will take on increased importance in organizations where the choice of technology exists. Evaluating these criteria and their associated costs is the only way to determine the best course of action. Each organization and potentially each use application within an organization will be different and will require evaluation based on the application's unique needs.

The final page of this paper provides a snapshot of the relative advantages and disadvantages of direct thermal technology vs. thermal transfer technology. While it may not be a comprehensive list for every application, it can provide an evaluation framework for most organizations.

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TYPE OF LABEL	METHOD	ADVANTAGES	DISADVANTAGES
Thermal Transfer	Thermal Transfer involves the printhead elements (dots) heating the backside of a carbon-based ribbon to transfer the carbon onto the media as a printed image	<ul style="list-style-type: none"> • Long life of printed image • Printed image does not fade in direct sunlight and is more heat tolerant • Availability of color ribbons • Typically, longer printhead life * • Wide selection of label materials • Good chemical resistance with some materials 	<ul style="list-style-type: none"> • Operators must perform ribbon changes • More mechanical parts in printer means potential for more downtime and mechanical failures • Opportunity for print quality problems due to mismatched labels and ribbons • Opportunity for print quality problems due to incorrect ribbon adjustments
Direct Thermal	Direct Thermal media is heat sensitive and reacts to the heated printhead elements (dots) to create an image. A thermal ribbon is not required.	<ul style="list-style-type: none"> • Simplified operator intervention; no ribbon to load or ribbon adjustments to make • No ribbon wrinkle problems • No mechanical failures associated with ribbon drive mechanisms • Fewer inventory items due to lack of ribbon and fewer spare parts • Eliminates potential for mismatched labels and ribbons • No ribbon disposal 	<ul style="list-style-type: none"> • Typically, slower print speeds • Typically, reduced thermal printhead life * • Will fade or "yellow" over extended periods of time *** • Label will darken when exposed to extreme heat and direct sunlight ** • Specialty substrates (i.e. films) can be costly • Limited selection of substrates • Limited chemical resistance

* When using the SATO M8459Se direct thermal print engine or the M5900Rve direct thermal printer, the specific printhead used in these models has an expected printhead life that compares favorably to thermal transfer printheads.

*** SATO America offers patented direct thermal materials that are more resistant to abrasion, direct sunlight, UV light and chemical contamination than traditional direct thermal media.

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