

# Best-in-Class Bar Coding:

*The Business Case for a Dedicated Thermal Label Printer*



A ZEBRA BLACK & WHITE PAPER





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## Executive Summary

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When businesses start planning their first bar code labeling applications, they are often tempted to try to modify their existing office printing systems to do the job. While laser, ink jet, and dot matrix printers can be made to output bar codes, dedicated thermal label printers are a much more convenient and ultimately cost effective option. The initial capital outlay for a dedicated thermal bar code labeling system will be more than offset by the productivity gains, quality advantages, and material savings that it provides compared to other print technologies, even for users who print labels infrequently.

This white paper will explain why a dedicated thermal printer is the superior choice for bar code label printing. The paper will:

- Provide an overview of thermal printing technology;
- Describe the bar code label capabilities and limitations of thermal, laser, ink jet and dot matrix print technology;
- Explain how thermal printer networking, connectivity, product design, and other features improve productivity of the printer and operator;
- Illustrate why thermal printers are more cost-effective for labeling than other technologies.

## Introduction

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You can pack 12 college students into a Volkswagen Beetle, but that doesn't make it a minivan. Similarly, you can coax office laser, ink jet, and dot matrix printers into printing a bar code, but that doesn't mean they are good tools for the job. Bar codes are not fonts or basic graphics but rather are intricate tools for automatically conveying information. They are used to communicate data more accurately and quickly than is possible by manual methods. These benefits can easily be lost if bar code generation is trusted to a general purpose printer that lacks the specific features necessary to ensure quality bar code output.

A dedicated thermal label printer provides quality, convenience, and cost-effectiveness to the user. The most basic models of bar code printers can create multiple bar code symbologies without special programming, connect to a variety of computer platforms and applications, and use label material that doesn't generate excessive waste or consistently jam, plus provide all the text and graphics necessary for labeling. Thermal bar code printers can easily accept and encode variable data without severely slowing print speed, can produce small labels to exact tolerances, and offer a full range of PC, network, and wireless interfaces for convenient connection and management in any IT environment.



## Benefits to Operations

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Thermal, laser, dot matrix, and ink jet print technologies each create bar codes in their own unique way. The thermal method is not just different from other technologies, it is advantageous. The exacting tolerances required for bar code printing demand much higher precision and print quality than is usually required for text printing on document printers. The standard print resolution and other functionality in some document printers is often insufficient for bar code printing, necessitating the use of higher-priced models. Encoding variable data, two-dimensional (2-D) symbols, or very small bar codes makes bar code printing much more challenging and is beyond the capabilities of some print technologies.

Using dedicated printers for label generation prevents delays and saves labor associated with multi-purpose print operations. If labeling responsibilities are added to an office printer, label jobs may get stuck in a lengthy print queue while documents and reports are being printed. This scenario is especially troublesome if users are rushing to prepare a batch of materials to meet the express parcel pick-up deadline and must contend with end-of-day reports or other documents being printed. Using a document printer for label generation often also requires label media to be loaded into the machine each time labels are needed and the plain paper to be replaced when the label printing is complete. The process may be repeated several times each day, and saving these minutes can add up to a noticeable improvement in productivity.

### **Total Cost of Ownership**

Thermal printing quality provides total cost of ownership (TCO) advantages over other print technologies. Because printheads and other components are designed for printing bar code labels rather than documents, labeling operations will not add excessive wear to the equipment or require premature repair and replacement. Using non-thermal printers results in more time being spent replacing parts, setting up new printers, clearing label jams, and swapping plain paper and label media, which reduces productivity and adds to the cost of the printing system. Additionally, industrial thermal printers are built to withstand dirt, dust, moisture, and vibration, so exposure to these conditions will not shorten the printer's life span.

Because thermal transfer printers accept the widest variety of media of all the print technologies mentioned, including polyester and other durable stocks, they can be used to create asset identification and other permanent labels on demand, eliminating the need to purchase preprinted labels or sheets of labels, as used in document printers.

Companies who must apply bar code labels to shipments for their customers are often subject to refused shipments or fines if the label falls off or is unreadable. Print quality is a necessity in this environment, which is why thermal printers are the dominant technology used in compliance labeling programs and other mission-critical bar code operations.

Thermal printers run reliably and can produce bar codes and labels without special handling, which provides numerous ongoing cost-saving and efficiency advantages. The advantages begin for the IT staff that installs and supports hardware or develops applications, and extend to the operators who use the printer on a regular basis.

### **Support and Ease of Use**

Thermal bar code printers are designed to print labels and typically have a Windows driver for integration into Windows-based applications, so they don't require specialized programming knowledge to create the desired output. There are dozens of labeling software packages that can drive specific types of thermal printers. These



packages can automatically encode data, size and generate bar code symbols, simplify label layout and design, perform data integrity checks, and interface with a variety of database, Windows, and ERP applications to gather the data necessary to generate bar code labels. These features eliminate hours of unnecessary and expensive programming time to develop special graphics and data handling applications, which other print technologies may require for bar code output.

Bar code label formats can be stored directly in the thermal printer's memory, which speeds processing and print speed. Bar code printers are also available with control panels that enable labels to be created directly from the printer without any connection to a PC, network, or PLC, so there are no additional costs for equipment purchase and support.

Even though a thermal bar code printer is a specialized tool, it does not need to represent a special burden to IT support operations. Thermal printers are available with parallel, serial, twinax, coax, Ethernet, USB, Bluetooth™, and 802.11b interfaces for connection to any enterprise IT environment.

Advanced printers can be assigned an IP address and integrated into networks through either a wired or wireless connection, so they can receive print jobs and can be managed in the same manner as any other device on the network. Furthermore, advanced bar code label printers have networking features that enable remote configuration and management and proactively send notifications to network administrators if media runs out or if other error conditions exist, which minimizes downtime and support requirements. These productivity-enhancing features are extremely valuable when printers are used for time-sensitive or high-volume applications.

For even greater time savings and productivity gains, mobile printers can be used to create labels wherever and whenever they are needed. One retailer recently calculated savings of 182.5 hours per store per year by using mobile printers, thus eliminating the need for workers to repeatedly walk to the back office to pick up labels for shelf labeling. Hotels, airlines, and other service business have improved customer satisfaction and retention by using mobile printers to reduce lines by printing bills, room keys, and boarding passes at the customer's convenience, and many retailers have improved sales with portable point-of-sale systems featuring mobile printers for receipt generation. See Zebra's white paper *Understanding Mobile Printing Technology and Capabilities* to learn more about mobile printing applications and advantages.

## Print Technologies and Bar Coding

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To understand and appreciate the benefits that thermal technology has over dot matrix, laser, and ink jet for bar code label production, you need a basic understanding of bar code symbols and how each print technology produces them. Bar codes must be produced within very tight tolerances, with the width of bars and spaces measured in mils, which are thousandths of an inch. Slight inconsistencies in bar width-or insufficient contrast between dark and light elements-can make the symbol unreadable and the data inaccessible. The following section provides an overview of each print technology, along with the advantages and disadvantages of each.

## Dot Matrix

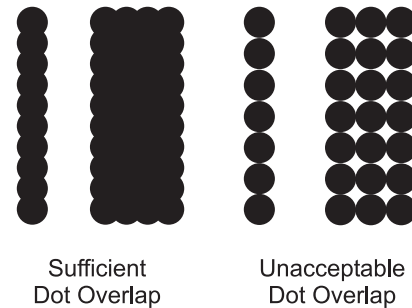
Dot matrix print technology is one of the oldest techniques used for on-site label printing. The typical dot matrix bar code printer is a modified line printer requiring pin-feed paper stock. Solenoid-driven needles strike an ink-coated nylon ribbon, transferring ink onto the paper or label. The image is built up dot-by-dot in a matrix as the needle and paper are moved relative to one another.

### Advantages

- Dot matrix printers are readily accessible and inexpensive to purchase.
- They can print on virtually any type of form, check, or document and can print on wide-web, multi-part (carbon) forms.
- Dot matrix printers use multi-pass ribbons, which can result in reduced overall cost for ribbons and label material.

### Limitations


- Dot matrix printers print low- to medium-density bar codes that may not meet certain end-user guidelines. The dot size on the matrix printer limits the size of the narrow element in the bar code, which restricts symbol density options. The illustration at right compares sufficient dot overlap vs. unacceptable dot overlap on a dot matrix printer used to print bar codes.
- Continuous ribbon re-use on dot matrix printers requires close monitoring of the ribbon's condition to ensure adequate bar code contrast. Ribbon ink that has become exhausted can also produce an image that is inadequate for scanning, resulting in a low read rate and high error rate.
- Ink saturation can result in paper "bleed" which can cause image distortion, such as bars becoming too wide and thus unreadable.
- A dot matrix-printed label has limited durability and media choices are restricted. Dot matrix printers typically cannot print on chemical- or water-resistant labels.
- Printing single labels results in significant waste. The design of the dot matrix printer's print carriage, sitting far below the media, also does not allow users to maximize the label space.
- Print speed is greatly reduced when best ink coverage is specified for optimal bar code print quality.



**Figure 1. Dot Overlap**

## Ink Jet

There are two types of ink jet printing: document printers commonly used in offices and with home computers, and industrial coding systems for high-speed marking on cartons and packaging in place of label printer/applicators. Desktop ink jets are a common and inexpensive choice for printing documents from home computers and in offices, while industrial coding systems are very large and expensive. Each has unique limitations and capabilities for bar code printing.



## Advantages

- Industrial direct ink jet printing requires only one step, while label printing requires two: printing a label and then applying it to the carton.
- Industrial coders can print directly on plastic and other product packaging materials.
- High-speed ink jet printing is a favorite on high-speed production lines due to its ability to mark “on-the-fly.”
- Desktop ink jet printers are inexpensive to purchase and easy to replace.
- Sheet-cut adhesive label material for desktop ink jets is readily available from office supply stores and catalogs.
- Many businesses already have ink jet printers for document printing.

## Limitations

- Installation costs are high for industrial ink jet coders because they are designed for high-volume bar code printing-not for individual or small-batch printing.
- Bar codes printed on the dark background of corrugated box materials suffer from poor contrast.
- Encoding variable data may slow print speed.
- Industrial ink jet printing requires diligent supervision and maintenance to ensure consistent print quality and to prevent ink jet clogging.
- Dot placement accuracy, bar code density, and resolution are limited with industrial coders because ink splatters and the print surfaces are in continual motion.
- Many desktop ink jet printers can only print labels by the sheet, resulting in waste and inefficient handling required for loading and handling label material.
- Processing variable data and formatting bar codes significantly slows desktop print speed. Productivity suffers when operators must wait for labels to come out of the printer.
- There is limited bar code and label design software support for desktop ink jet printers.

Durability and reliability are limited when desktop ink jet printers are used in non-office environments. Desktop ink jet printers are not designed to withstand dust, dirt, vibrations, and other environmental conditions common in shipping areas, which leads to increased maintenance and reduced lifespan.



## Laser

The laser printer works much like a photocopier; it projects controlled streams of ions onto the surface of a print drum, resulting in a charged image. The charged image then selectively attracts toner particles, transferring the image onto the paper substrate by means of pressure. The pressure from the printhead and drum then fuse the image to the paper, creating the image.

### Advantages

- Laser printers are good at producing plain-paper documents that require bar codes.
- They can print high-quality text and graphics on paper documents and can double as a document printer when not being used to print bar codes.
- Bar code density and resolution are also quite high on laser printers, resulting in high quality symbols.

### Limitations

- Laser printers can be wasteful because they cannot produce single or small labels. A minimum of half a page of media is typically required for the printer to maintain control of the sheet. Unless the label is at least that size or multiple labels are needed at once, the remainder is wasted.
- Laser printer label adhesives must be carefully selected to ensure stability under the heat and pressure of the fuser. Otherwise, the adhesive may seep onto the printer mechanism, where it will capture stray toner, or the adhesive may cause the labels to curl at the edges.
- Because of the pressures used in the image transfer process, many laminated label materials are not compatible with laser printing. Those materials that are compatible may not always be available in the sheet form necessary for laser printing.
- A laser-printed paper label has limited durability. Laser printers cannot produce chemical- or water-resistant labels and images, for example.
- With laser printers, toner, drum, and supply costs can skyrocket when printing bar codes instead of typical text. While text printing requires only about five percent black toner, bar code needs can exceed 30 percent to ensure proper contrast between dark and light elements. Toner costs alone could be six times higher when printing bar codes rather than text.

## Thermal

Thermal printing is classified as either direct thermal or thermal transfer. The two technologies are suited to different applications.





## Direct Thermal Printing

Direct thermal printing is an old technology, originally designed for copiers and fax machines, that utilizes chemically coated paper. It has since been transformed into a highly successful technology for bar coding. The direct thermal printhead consists of a long, linear array of tiny resistive heating elements (about 100 to 300 per inch) that are arranged perpendicular to the paper flow. Each printhead element locally heats an area directly below it on the chemically coated paper. This produces a chemical reaction that causes a black dot to form in that area. The image is built by rows of dots that are formed as the media passes beneath the active edge of the printhead.

### Advantages

- Direct thermal printing produces sharp print quality with good readability.
- Direct thermal printers are simple to operate compared to most other print technologies, with no ink, toner, or ribbon to monitor or replenish.
- With no supplies to replace other than the material to be printed, long-term maintenance costs and total cost of ownership remain low.
- Direct thermal printers enable batch or single-label printing with virtually no waste.
- With recyclable materials available, direct thermal printers offer environmental economy.
- Direct thermal printers, like thermal transfer printers, are typically built more durably than dot matrix or laser printers, allowing reliable operation in industrial as well as office applications.

### Limitations


- Direct thermal printing is sensitive to environmental conditions such as heat and light (fluorescent and/or direct sunlight).
- Direct thermal paper remains chemically active after printing. Because of this, thermal labels, tags, or ticket stock are often top-coated to resist UV light exposure, chemicals, and abrasion.

## Thermal Transfer

Thermal transfer printers use the same basic technology as direct thermal printers, but replace the chemically coated material with a non-sensitized label stock and a special, inked ribbon. This durable, polyester ribbon film coated with dry thermal transfer ink is placed between the thermal printhead and label. The thermal printhead transfers the ink onto the label surface, where it cools and anchors to the media surface. The polyester ribbon is then peeled away, leaving behind a stable, passive image.

### Advantages

- Thermal transfer delivers crisp, high-definition text, graphic, and bar code print quality for maximum readability and scannability.
- Thermal transfer printing produces long life image stability.
- Thermal transfer enables batch or single-label printing with virtually no label waste.
- Long-term maintenance costs are low compared to dot matrix, ink jet, and laser printing.
- Thermal transfer technology can print on a nearly unlimited variety of media stock (except multi-form).

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- Thermal transfer printers are typically built more durably than dot matrix or laser printers, allowing reliable operation in industrial as well as office applications.

#### Limitations

- Since thermal transfer printers require ribbon, supply costs are higher than direct thermal. Printheads last longer when printing in thermal transfer mode than in direct thermal, however.
- Single-pass thermal transfer ribbon can be wasteful if little data is printed on the label.
- Thermal transfer ribbon is a poor candidate for recycling.
- To obtain optimum print quality in thermal transfer printing, the ribbon and media substrate must be compatible. Otherwise, the heat from the printhead could melt the ribbon onto the label causing smearing and potential internal printer problems.

## C o n c l u s i o n

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To evaluate whether your bar code printing needs can be satisfied with existing equipment or would benefit from a dedicated label printer, consider the following:

- What is the expected print volume and how will that impact operator and printer productivity?
- Can existing printers efficiently produce the required label size?
- What are the expected monthly supplies costs?
- Is print quality important? What will happen if bar codes are unreadable?
- How much initial set up and programming time is required? Can it be done in-house?
- How much ongoing IT support and operator time will be required to use and maintain the system?
- If label requirements change, can modifications be made internally or will outside support be required?
- Can the equipment function in the environments where labels are needed?
- How will bar code label printing impact equipment performance?
- How often will printers need to be replaced or repaired?

Thermal bar code label printers are built to satisfy these concerns. From their initial setup, to daily use and long-term maintenance, dedicated thermal printers are the most cost-effective and convenient option for bar code labeling. Users will enjoy operating cost, ease-of-use and reliability benefits whether they print a few labels a week or hundreds of labels a day. Bar coding is a sophisticated print operation that requires a specialty printer. Dozens of printer models are available to precisely satisfy different user requirements for print volume, speed, symbologies, label materials, interfaces, and other features.

Zebra Technologies offers the widest range of bar code and printers in the industry and supports them extensively with software, connectivity solutions and supplies. More than 90 percent of Fortune 500 companies use Zebra®-brand printers. Contact Zebra today at +1 800 423 0442 or visit our Web site at [www.zebra.com](http://www.zebra.com) to learn more about how we can help satisfy your exact needs with a dedicated bar code label printer.





## Notes

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