



# Visibility that's Visionary: Ensure Outstanding Print Quality From Your Direct-to-card and Retransfer Card Printers

## A FOCUSED LOOK AT FACTORS FAR BEYOND RESOLUTION

When printing cards—whether they are gift or high-security government identification cards, or anything in between—users need to produce professional-looking cards with outstanding images, crisp text and barcodes that scan reliably. Together, these elements determine overall print quality.

Print quality is often thought to be dependent on resolution—how many dots per inch can be printed. However, resolution is only one aspect. Print quality is directly dependent on many factors, such as the type of printer (retransfer versus direct-to-card), type and quality of media, printhead quality, mechanical design, software, firmware and numerous others—even including power supply. With so many considerations, where to focus?

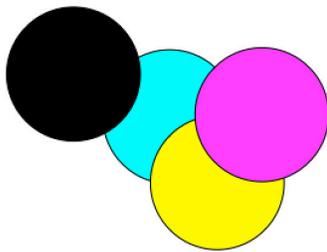
## Laying the Foundation: Printer and Media Types

As a foundation, printer type is the first area of focus. Direct-to-card print technology is both common and affordable. This method requires the printhead to come into contact with the card via the ribbon as it prints directly on the card surface. Direct-to-card printers cannot print on the edge of the card, often leaving a visible border around the printed image. And, they can't print reliably on uneven card surfaces such as key tag or smart cards.

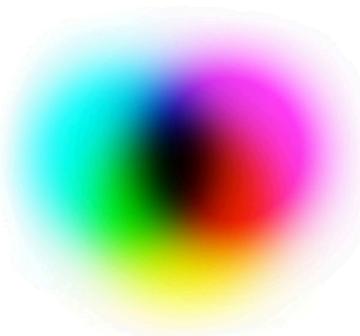
Because the print process is on a special color print-receptive material, retransfer print technology gives users optimal image quality with vibrant and rich colors, even on card surfaces that are not perfectly flat such as smart cards. Card images are printed to a clear, retransfer film that is fused to the card surface creating a more durable, scratch-resistant product. Images can be printed "over the edge" eliminating white borders around the card edge. And, retransfer printing allows users to print on more durable, non-PVC-based card types such as polycarbonate, teslin and PETG. Giving users built-in fraud protection with the tamper-evident retransfer process, retransfer film is thermally bonded to the card and can't be removed without being damaged. Inherent in its design, the retransfer process provides a protective layer over the image eliminating the need for an overlay or varnish for extra durability.

The second overarching area of focus is media or ribbon type, specifically dye diffusion versus mass transfer media. Dyes (typically YMC: yellow, magenta and cyan) are diffused onto the receiving media and blend together to create millions of colors. Dye diffusion is when the dye penetrates the surface of the card and infuses into it, which allows it to chemically bond with the surface of the card. With dye-based media, users can vary the YMC intensity of each pixel by increasing or decreasing the amount of heat applied. This allows users to print very high-quality, smooth, continuous-tone images with excellent color rendering for the largest range of colors possible. Dyes are more likely to fade due to UV exposure and require an overlay for direct-to-card printers, retransfer film that is inherent in retransfer printers, or a laminate patch for security applications to seal the card.

Most commonly used, mass transfer media includes waxes, resins and pigments. Mass transfer media is transferred to cards as a constant amount of resin or wax per dot, creating consistent dots of color that do not vary in shade. Waxes and resins are monochrome, usually black, but also available in other colors like blue, red, white, silver, etc. Waxes and resins are best suited for barcodes, text, simple graphics or logos, or anything with a "spot" color versus full color. To achieve rich, dark black, users will realize best results using a mass transfer ribbon. Mass transfer media can also produce full-color images by mixing YMC pigments. Since the pigments are a constant intensity for each pixel color, shades are created by varying the amount and spacing of YMC dots placed on the card. To produce visually acceptable color quality with mass transfer media, printers must have a much higher print resolution than with dye-based media.



MASS TRANSFER (RESINS AND PIGMENTS)



DYES

### WHAT DO USERS WANT FROM THEIR CARD PRINTERS?

**Print Quality:**  
**Key component users want**

- Cards must look outstanding
- Text must be clearly legible
- Barcodes must scan reliably

**Fast Print Speeds**

- Complete print jobs quickly and efficiently
- Reduce printer oversight

**Flexibility**

- Ability to handle a variety of card types
- Specialty ribbons for spot printing and smart cards

**Reasonable Cost**

- Price of printer
- Cost of supplies
- Overall costs of operation and maintenance

Once you've determined your printer and media type, there are many other considerations when it comes to print quality. Let's look at the critical factors that impact print quality, and how users can leverage this information to produce professional quality cards with exceptional images, graphics, text and barcodes.

Additionally, learn how Zebra® card printers further address print quality through proven, patented Color Predictive Technology algorithms that constantly monitor printing and instantaneously adapt printer settings to automatically produce the highest print quality.

## Top Customer Priority: Print Quality

### TOP 7 FACTORS THAT IMPACT PRINT QUALITY:

See Table on next page for more details.



	Factor	What is it?	Effects
1	Mis-registration	<ul style="list-style-type: none"> <li>• Color Panel Alignment</li> <li>• K Panel Registration</li> <li>• Progressive Mis-registration</li> </ul>	<p>Misalignment of the color and/or black panels can cause gaps in color or improper coloring. Progressive mis-registration is caused by a change in friction between the printhead and ribbon, specifically the friction difference between “on” and “off” pixels and the quality of the media and printhead. This can cause unwanted areas of white or incorrect coloring on printed cards from the leading edge to the trailing edge of the card.</p>
2	Tone Scale	Visually Appealing and Natural Color Range	<p>Contrast: ability to print smoothly varying levels of density from light to dark to provide image detail in dark shadows and bright highlights. Properly adjusted contrast provides more “pop” in the image with deep, vibrant colors versus flat, dull-looking colors. Part of contrast, grayscale is the ability to smoothly print a range of gray values—from white to black.</p> <p>Dynamic Range: the breadth of range between the lightest white and darkest black. High dynamic range provides image details in dark shadow regions as well as bright highlight areas.</p>
3	Color Accuracy and Intensity	Does the Coloring of the Digital Image Match the Printed Card?	How vibrant are the colors, and are the colors accurate as compared to viewing the digital image?
4	Resolution	Dots Per Inch Printed: 300 vs. 600, etc.	Resolution is most noticeable on monochrome text, especially small fonts printed using mass transfer media. Resolution is a property of the spacing of the elements on the printhead, and can also be impacted by media and printer settings.
5	Color Bleed	Thermal and Ink Smear	Thermal Smear: caused by residual heat build-up in the printhead, media, card and printer itself, which can create unwanted dye transfers.
6	Uniformity	Printer Design and Supplies Quality	<p>Printer Design: printer engineering and components. Inferior mechanical design can cause unwanted artifacts, reduce color consistency and diminish print quality.</p> <p>Supplies Quality: quality of the cards, ribbons and laminates. Poor quality supplies can result in uneven coloring, card warping and jamming, torn ribbon, as well as sections of cards that are unprinted.</p>
7	Transfer Performance (retransfer printers only)	Ability to Consistently and Accurately Adhere the Transfer Film to the Card	Creates a durable product; poor transfer performance delivers poor-looking cards.

# What Factors Impact and Create Print Quality in a Card Printer?

## 1. Mis-registration: Color Panel Alignment, K Panel Registration, Progressive Mis-registration

Mis-registration occurs where there is a panel-to-panel misalignment—such as yellow, magenta or cyan panels—in relation to each other on the card. It is typically caused by card staging errors between color passes. If any of the panels are out of sync, it can cause areas of an image to have a color “halo” or “fringe” around it. Misalignment of the black (K) panel to the YMC panels can happen as well, causing areas that should be black to have a white edge or border along them. Misalignment of the color and/or black panels can cause gaps in color or improper coloring.

Even when all panels are aligned to each other, you must ensure that those panels are also aligned to the card. The same applies for retransfer film. Even when aligned to each other, if those panels or retransfer mechanism begins printing too early or too late, the image will not be placed on the card accurately, leaving a white space on the card.

Progressive mis-registration is demonstrated by registration deteriorating from the leading edge to trailing edge of the card. It is caused by friction between the printhead and ribbon during the printing process as pixels are turned on and off. When pixels are “on” there is more heat applied and less friction between ribbon and card. When pixels are “off” there is less heat applied and more friction between ribbon and card. This friction can cause unwanted areas of white or incorrect coloring on printed cards.

Using inferior ribbons can increase the possibility of progressive mis-registration.



**User Takeaway:** By ensuring proper registration of panels, laminate and cards—and monitoring printhead heat—Zebra helps you avoid mis-registration challenges. As a part of Zebra’s exclusive Color Predictive Technology (CPT) based on patented image-processing algorithms, Zebra printers have a preheat variable within the print driver to help reduce this issue and deliver improved print and image quality. Also, Genuine Zebra™ ribbons contain a specially formulated slipcoat coating on top of the ribbon to reduce friction so it easily slips past the printhead during printing to reduce the possibility of progressive mis-registration.

## 2. Tone Scale: Visually Appealing and Natural Color Range

Tone scale, also called dynamic range, encompasses the breadth of range between the lightest white and darkest black to provide image details in shadow and highlight areas. A key element of tone scale, contrast is the ability to print smoothly varying levels of density from light to dark to provide image detail in dark shadows and bright highlights. Good contrast produces images with more “pop” in color versus looking flat, and colors are deep and vibrant.

Part of contrast, grayscale is the ability to smoothly print a range of gray values—from white to black. Poor grayscale results in dark, muddy blacks and overly blown out white highlight areas with no detail. A poor tone scale response could also produce shades of gray that are not neutral, instead showing a colorcast.

Printhead energy control is critical to contrast and tone scale response. Card printers need to continually monitor printhead energy to ensure heat is correctly applied throughout the process for a smooth-looking image.

**User Takeaway:** Through printhead energy control management you can better ensure accurate tone scale, producing images with consistent contrast and grayscale. Zebra's CPT features algorithms to enhance printhead energy control and ensure an optimal tone scale response.

### 3. Color Accuracy and Intensity: Does the Coloring of the Digital Image Match the Printed Card?

Color accuracy and intensity, or ensuring your printed card matches the digital proof on a calibrated monitor, is especially important for graphics and images such as photographs. You want the printed output to look like the person in real life for security purposes, or the printed logo to accurately represent a company brand. This requires correct color intensity and darkness. The longer the heat is turned on in the printhead, the more intense and darker the colors will be. When printing dark blacks the printhead heat is intensified, creating a higher possibility of ribbon wrinkle and tearing.

**User Takeaway:** Monitoring printhead heat when printing rich, intense colors is critical. Zebra's ZXP Series™ printers feature a color optimization tab in the driver to help users manage settings and control intensity. Zebra's CPT algorithms automatically adjust the printhead energy up or down on a pixel-by-pixel basis during printing to ensure the richest color and eliminate print artifacts.

### 4. Resolution: Dots Per Inch (dpi)

Printer resolution is a fixed property of the printhead—how many heater elements are in the printhead. Print quality, or producing visually appealing images, is dependent on much more than just dpi resolution.

Printed images using dyes require less resolution than when using mass transfer media for an equivalent result. Dyes can blend colors by increasing and decreasing heat. Mass transfer requires more pixels as dots need to be placed closer together to deliver a blend of colors and smooth appearance. When printing colorful graphics and images, using dyes will give you the widest range of possible colors and the smoothest looking images.

When printing monochrome fine text, small fonts and barcodes, using mass transfer media with higher resolution is ideal. These items will look crisper with higher resolution; tiny fonts being the most noticeable.

**User Takeaway:** Resolution alone doesn't deliver outstanding image or print quality. Combining the appropriate printer type, media and resolution for your application will produce the best result.



COMPETITOR 1  
600 DPI



COMPETITOR 2  
600 DPI



ZXP SERIES 9  
300 DPI

## 5. Color Bleed: Thermal and Ink Smear

Thermal smear is created by residual heat buildup in the printhead, media, card and printer itself, which can cause additional unwanted dye or resin to be transferred on subsequent lines of the image. The problem gets worse as printing speeds increase and the printhead has less time to dissipate the residual heat.



Smear artifacts occur when the printhead is printing predominately high-density areas and then transitions to a lighter area. The dark area needs to be ahead of (closer to the lead edge) than the light area for smear to occur. White or light text surrounded by dark areas can also exhibit smear artifacts. The white/light text may look discolored or darker than it should, especially near the edge of the dark to light transition. Transitions from light to dark from the lead edge to the trail edge will not show smear artifacts, instead lead edges will appear blurred or fuzzy. Image design can help reduce/prevent thermal smear, along with preheat adjustments in the driver.

**User Takeaway:** Zebra’s CPT features algorithms designed to continually adjust the heat in real time on a pixel-by-pixel basis during printing to minimize smear and associated artifacts. ZXP Series printers have a preheat adjustment in the driver to help increase sharpness on light to dark edge transitions. These algorithms also monitor printhead temperatures to minimize the risk of inadvertent color transfer due to increased heat, or boost heat when the printhead is cool for optimal color transfer. Zebra’s ZXP Series 9™ printer also features a user-selectable “Fine” print mode, designed especially for printing rich graphics and images. It reduces unwanted residual heat buildup by slightly slowing down the print speed, which maximizes the effectiveness of CPT. This enables the ZXP Series 9 printer to produce the richest colors and crispest edges, while minimizing the risk of smearing and ribbon wrinkle/tearing.

## 6. Uniformity: Printer Design and Supplies Quality

Uniformity, or the ability for the printer to provide consistent performance, is affected by numerous factors. Inferior mechanical design—including printhead variations, poor ribbon path design and tension, uneven printhead pressure, inconsistent power supply, and unsmooth card movement—can cause unwanted artifacts, reduce color consistency and diminish print quality. At the same time, poor quality supplies—such as imperfections in the card surface and non-uniform ribbon or retransfer media—can result in uneven coloring, card warping and jamming, torn ribbon, as well as sections of cards that are unprinted.

**User Takeaway:** Zebra engineers its printers to ensure the highest quality products with proven dependability. Incorporating superior components and innovative design, Zebra’s ZXP Series card printers are produced with extensive quality control oversight and rigorous specifications to give you the highest print quality—card after card. Developed specifically to pair with Zebra’s ZXP Series card printers, Genuine Zebra supplies—including cards, ribbons and laminates—provide outstanding quality and consistent, optimal performance. And, Zebra’s cleaning supplies help you keep your printer in top condition.

## 7. Transfer Performance (Retransfer Printers Only): Ability to Consistently and Accurately Adhere the Transfer Film to the Card

With retransfer printing, images are first printed to the retransfer film, which is then bonded to the card using heat and pressure. Maintaining appropriate heat and dwell time during the transfer process is critical to successful retransfer card printing. Too much energy applied to the card increases the risk of warped or damaged cards. Conversely, too little energy results in incomplete transfer, and transfer film that chips or flakes.

The quality of the retransfer film directly affects the final print quality. Inferior retransfer film can warp or wrinkle, or cause incomplete transfer.

Additionally, different retransfer settings are required for different types of cards and must be changed for each.

**User Takeaway:** Zebra has conducted extensive quality control testing to ensure that its retransfer printers deliver outstanding, consistent transfer performance. And, Genuine Zebra cards and retransfer film meet stringent quality standards to deliver consistent results with every print job and minimize wear and tear on critical printer parts.

Zebra card printers enable users to create and save custom retransfer settings within the driver for non-standard card needs. Additionally, customers using non-standard cards can contact Zebra for assistance in determining optimal, custom retransfer printer settings.



## Final Summary and User Takeaway:

### VISIBILITY THAT'S VISIONARY

Zebra's Color Predictive Technology, Along With Our Best-in-class Engineering and Supplies, Deliver Outstanding Print Quality On All Our ZXP Series Card Printers.

### WHAT IS ZEBRA'S COLOR PREDICTIVE TECHNOLOGY?

Zebra's CPT, based on patented image-processing algorithms, is included on all of Zebra's ZXP Series card printers. This tested and demonstrated technology enables your printer to constantly monitor and assess printing content and history, automatically calculate and make needed adjustments in real time to ensure your printer produces the highest print quality and ideal images every time. This function happens inherently within the printer—no operator oversight is required.

### ADDITIONAL CONTROLS AND BENEFITS

Zebra's ZXP Series card printers feature an innovative design and are manufactured using high-quality components. Produced with extensive quality control oversight and rigorous specifications, ZXP Series card printers give you exceptional print quality. Further ensure print quality and optimal performance when you select Genuine Zebra supplies. Zebra's supplies are guaranteed to meet stringent quality standards to help you achieve consistent results with every print job, and minimize wear and tear on your printer.

Zebra ZXP Series card printers also offer an intuitive user interface and toolbox so you can fine-tune controls and settings to match your applications. And, Zebra card printers are known for their industry-leading print speeds. So, you can produce top-quality cards quickly.

### THE RESULT:

With Zebra ZXP Series card printers and supplies, you experience consistently outstanding print quality, minimal operator oversight, fast throughput and professional-looking card products.

Information about Zebra and Zebra-brand products can be found  
at [www.zebra.com](http://www.zebra.com)



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