



PRECISIONCORE

Next-Generation Inkjet Technology

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1. Breakthrough PrecisionCore Technology (Executive Summary)

PrecisionCore, Epson's latest advance in the 500-year-old craft of printing, promises outstanding increases in speed along with improved output quality, bringing inkjet printing to a new level. The heart of the technology is a next-generation print chip, based on micro-electro-mechanical systems (MEMS) technology, which uses a 1-micron thin piezo actuator that acts like a pump to deposit ink with dramatic speed and precision. PrecisionCore continues and extends Epson's tradition of providing renowned color quality and output durability across the widest range of applications.

PrecisionCore is a highly scalable technology suited for products ranging from desktop printers to industrial systems such as large-scale label presses. Its modularity allows PrecisionCore print chips to be arrayed in both moving serial printhead and fixed linehead configurations. And use of piezo technology allows great freedom in ink chemistry, facilitating printing on a broad variety of substrates.

PrecisionCore is the product of one of the largest investments in research and development in Epson's history. It merges advances in materials science and MEMS fabrication to continue to expand the company's leadership in the print industry. It continues the march toward ever more affordable inkjets, demonstrating Epson's continued commitment to providing customers with best-in-class capabilities.

Epson now has multiple opportunities to utilize the advantages of these new print chips across its product line in volumes and with economies of scale that few can match. PrecisionCore print chips give the company the ability to build the next generation of high-performance inkjet printers that can replace entire market segments, including office laser printers, commercial screen printers, and traditional analog presses.

In the following pages, Epson proudly introduces you to PrecisionCore's grand design. Put simply, the ability to pump larger amounts of fluid through densely packed nozzles yields a multitude of small, round, precise dots. For the customer, this translates into better and faster output.

2. Meeting Customers' Need for Speed, Economy, and Flexibility

Printing has been central to global culture and economics since Gutenberg introduced moveable type to Europe around 1440. Over the past decade, growth in the value of printing has averaged 1% a year and now stands at \$800 billion¹. Printing takes place everywhere from home offices to gargantuan manufacturing sites.

Yet, after more than 500 years of printing, the majority of office printing is still monochrome. In factories, millions of preprinted analog labels must be disposed of monthly as SKU demand changes, and textile manufacturers must commit to fashion trends a year in advance. The demand for performance will only grow in the future, driven by made-to-order products, labels, and packaging requiring “just in time” delivery and variable data. The effect of the move from mass marketing to mass personalization is that print runs will continue to get shorter, pushing the boundaries on cost and speed.

In recent years, digital print has demonstrated the benefits of on-demand flexibility, but to continue its rapid growth it must deliver even greater speeds with no compromises in established expectations of print quality. By meeting these needs, inkjet print usage is expected to grow rapidly in the two largest printer market segments. The first is where traditional analog presses currently dominate and the second is where office laser printers currently dominate.

While traditional analog presses are fast, they are only cost-effective when producing high volumes of identical output. At lower volumes, their overhead costs, including platemaking and press make-ready, drive their amortized per-print costs to non-economical levels. Consequently, digital inkjet printers are already starting to replace analog presses for short-run labels and garments. Not only are they easier to setup but they can deliver customized content on every piece.

The remaining bulk of the world's current print volume comes from office laser printers, along with a few commercial grade dry and liquid toner devices. A new generation of inkjet products is emerging that combine laser printer duty cycles and text quality with inkjet color and efficiencies, but at the ever higher speeds that we are starting to see from commercial inkjet products. This new generation of inkjet printers will continue to become more prominent in the segment now dominated by office laser printers at an even more rapid pace.

To meet this challenge fully, Epson offers customers dramatically faster speeds and on-demand flexibility with the introduction of its PrecisionCore scalable print chip. PrecisionCore extends the industry-leading piezo performance of its commercial printers both upwards to the industrial press, and downwards to the desktop.

3. Epson's \$300 Million Solution: Merging Material Science with MEMS Manufacturing

Epson's strengths lie in its culture of *'Monozukuri'*; a Japanese concept meaning 'the art and science of manufacturing.' From its roots in watch-making, the company has developed expertise in material selection, manufacturing and high-precision processing. Whether applied to the inner workings of a mechanical watch, or the micron-scale structures of a print head, Epson is able to draw on decades of experience in space-efficient design and quality assurance.

When the company began working on inkjet technologies in the 1980s, Epson chose a piezo process, in which a thin crystal flexes when an electric charge is applied to it. As the crystal deflects, it acts as a pump to push the ink through a nozzle. The process has the advantage of being able to handle almost any fluid with great precision and durability.

In 2003, having already revolutionized photo-printing by bringing it into the home, Epson set its sights on truly realizing the potential of piezo printhead technology. To achieve the high-speed, high-quality, high-reliability, and high-efficiency printing demanded by the commercial industry, it was necessary to develop the thinnest possible piezo element for maximum control over drop size. The result was the 2007 launch of Epson Thin Film Piezo (TFP)—and the foundation of PrecisionCore technology.

The development of piezo crystal films just 1 micron thick—one hundredth the thickness of a human hair—allowed the maximum output of ink from the smallest print engine, allowing a big increase in the density of print nozzles. Combined with precise ink channels and nozzles, TFP print heads are able to place almost perfectly round dots on media with great precision.

Since 2007, TFP has been Epson's flagship technology for large-format printers, where fine image quality is required to create large posters and advertising with outstanding detail, color expression, and increased productivity. PrecisionCore printhead technology builds on the company's materials science skills and MEMS manufacturing technology to extend the TFP accomplishment to a wider range of printing applications.

The product of this revolutionary advancement in technology, the PrecisionCore MicroTFP print chip, doubles the piezo actuator's flexing power compared to the original TFP printhead. This, together with a redesign of the ink flow path, electronics, and other components, allows greater miniaturization. These modular print chips can be combined in various ways that let Epson develop a wide range of both serial printheads and fixed lineheads, all sharing the same core high-performance. This scalability will allow Epson to fully leverage the inherent durability and ink flexibility of its piezo printheads across an even wider range of applications, from commercial printers and industrial presses for posters, labels and textiles, to desktop document printers.

Providing the finest in image quality in the industry has been Epson's mission since the launch of its first consumer inkjet in 1993. Through PrecisionCore, the company's leadership has not just been preserved, it has been extended. Encompassing both the proven TFP and new MicroTFP-based print heads, PrecisionCore embodies Epson's goal to bring the highest level of performance and value to the widest range of customers.



PrecisionCore MicroTFP print chip

4. How PrecisionCore Achieves Dramatic Speed

Speed and power are two important aspects of the vehicles we depend on. Everybody loves the feeling of speeding around in a sports car, but it's the efficient power of trucks, trains and ships that move the world's goods to market. Both the speedy sports car and the high-capacity truck serve a purpose in the world; the choice depends on your need.

PrecisionCore printhead technology serves as a platform that can deliver both the speed and power that are the ultimate drivers of economic output in the world of printing. The PrecisionCore printheads have two to three times the resolution of Epson's conventional piezo printheads. They can be fast and powerful at the same time, with the ability both to fire quickly and deliver multiple drop volumes on demand. For pure speed, consider Epson's large-format printers whose moving PrecisionCore piezo elements each fire nearly 50,000 times per second. Pure power? While PrecisionCore printhead nozzles can deliver drops as small as 1.5 picoliters (pl) (1.5 trillionths of a liter), they can also deliver drops of up to 32.5 pl. The whole package? Consider the new PrecisionCore linehead assembly that brings 52,800 nozzles together to produce 15 meters of output per minute in the new Epson SurePress L-6034VW industrial label press.

Variable Drop Size for Precision and Coverage

It is important to note that in piezo inkjet systems, increasing printhead resolution generally brings with it a corresponding decrease in the displacement of the piezo actuator and thus the volume of ink you can jet in a single firing of the nozzle. In some situations, this may actually be desirable, though for certain inks or printing surfaces this may require more passes by the printhead or more nozzles to achieve the required volume of ink. PrecisionCore's strength is its powerful high displacement piezo element that enables it to deliver both large and small drop volumes even at high resolution, thereby overcoming this barrier.

Whether you need large areas of solid color covered quickly, details such as gradation covered precisely, or even both at the same time, the efficient nozzles of PrecisionCore can efficiently and precisely deliver the most appropriate amount of ink to achieve high-quality, high-speed printing. Inch for inch, the high-resolution Epson print chips are one of the fastest inkjet printing technologies in the world. The table below illustrates the performance of PrecisionCore technology.



PrecisionCore TFP print chip



PrecisionCore MicroTFP print chip

	TFP print chip	MicroTFP print chip
Nozzles per inch:	720	600
Nozzle line length	25.4mm (1 inch)	33.8mm (1.33 inch)
Nozzles per print chip:	720 (2 rows of 360)	800 (2 rows of 400)
Drop size	1.5 – 32.5 picoliters	
Operating frequency	Up to 50 kHz	
Per-row ink ejection capacity	113 µl/sec	130 µl/sec

Table 1: PrecisionCore print chip specifications



5-chip TFP serial printhead for large format printers



SurePress L-6034 11-chip 33 cm linehead

PrecisionCore print chip speed can apply to Epson's moving serial printheads or fixed single-pass lineheads.

Like using more than one engine to pull a large locomotive train, PrecisionCore heads can be assembled together to achieve page width coverage for higher speeds, for example, the 66 chips in the SurePress L-6034VW inkjet press. This scaled combination delivers continuous single-pass speeds of 15 meters per minute over 33 cm (13 in) wide media, with six edge-to-edge, fixed lineheads. For comparison, this new fixed head SurePress L-6034VW runs five times faster than the multi-pass serial printhead SurePress L-4033AW. Now, that is dramatic speed.

Fast Decision Making, Precise Media Handling

To make the most of this speed, high performance data transfer and controller integrated circuits are also required. Each printer relies on complex image processing to determine the optimum combination of inks and drop sizes to achieve the best quality image, and these calculations are usually performed on powerful, Epson-designed and built integrated circuits. The SurePress L-6034VW numbers are staggering: printing at 600x600 dpi on paper flying past at 15 meters (590 inches) per minute requires almost two and a half billion decisions about whether to fire a drop, and what size drop, must be made every single second.

The media must also keep up. In the SurePress L-6034VW, continuous paper feed keeps the paper smoothly moving and aligned within 2.5mm underneath the print-head assembly, ensuring spectacular output. The press can even move the media in reverse when necessary while maintaining precise registration.

In summary, Epson recognized early on that making high-speed printing a reality required in-house development and integration of key technologies, such as high-density, high-frequency nozzles, scalable print chips, industry-leading ink formulations, and precise, continuous media feed.

5. Professional Output Quality and Durability

Epson's PrecisionCore printheads and printing systems can hold their own in the speed wars, but let's take a closer look at the resolution, dot precision, durability and flexibility that PrecisionCore brings to the print marketplace.

Professional Quality

Image quality depends on a variety of factors. PrecisionCore has up to triple the nozzle density of conventional piezo printheads with native output at either 600 or 720 dpi per print chip. This level of performance is already sufficient for many print applications, but adding consistently precise drop control and the variable drop sizes possible with piezo technology means that perceived resolution of output from a PrecisionCore system can be much greater than the standard dpi resolution measurement.

The ability to control dot sizes by controlling the voltage passing through the piezo element was one of the reasons Epson originally chose this technology. The PrecisionCore print chip's MEMS nozzles accentuate this core attribute. The illustration on the left shows these perfectly formed nozzles, roughly 20 microns in diameter.

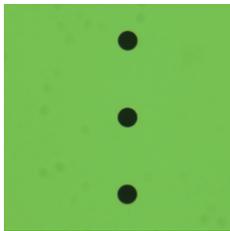
Below that is an actual photo of the small, round, repeatable dots that these nozzles produce. For reference, these dots are about 40 microns across.

If Epson's PrecisionCore puts that much quality in a single dot, consider for a moment the quality that it puts into an entire image. It's no surprise Epson leads in categories that demand the highest print quality standards, such as the professional graphic arts and digital proofing industries. Dot precision is also particularly important for creating sharp text and fine lines in documents. And, accurate control of the dot form and placement contribute to output quality by enabling minute adjustments to compensate for different media, ink types, and print speeds across a range of commercial and industrial printing applications.

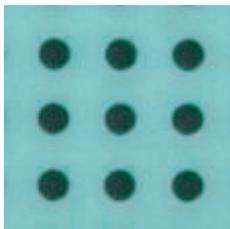
PrecisionCore uses its nozzles efficiently. Its "on the fly" variable drop architecture enables it to select from several different dot sizes with each pulse of the nozzle for superior results. The design allows PrecisionCore to deliver high-speed media coverage by selecting a large drop size at an impressively fast firing rate. PrecisionCore nozzles can also reconfigure themselves in around 1/10,000 of a second to deliver small and beautifully round drops, allowing for sharp text and smooth edges and gradations, as well as fast area fills.

PrecisionCore printhead technology gives Epson immense flexibility in the fluids it jets (see Tech Focus for details). For printing systems, this translates to the widest variety of inks, allowing Epson printers to produce the widest range of color (gamut) without having to resort to papers with specialized coatings. The use of plain media, which looks anything but plain when printed on by Epson printers, presents an opportunity for significant cost savings over costly coated papers.

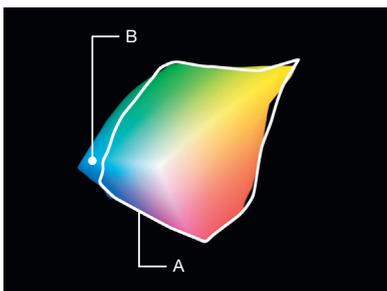
The gamut chart here shows how the color range of the next-generation Epson pigment inks for business inkjet printing is comparable to a laser printer of the same class. This is due to the high pigment ratio and quick-drying nature of the Epson ink that enables more of the critical colorant to remain on or near the surface of the paper.



PrecisionCore nozzle plate



PrecisionCore's round dots



Gamut comparison of Epson laser printer (A) and next-generation pigment ink for business inkjet printers (B)

UV inks are notoriously difficult to use reliably in inkjet systems, but the SurePress L-6034V successfully uses them to print on a wider range of label materials than competing systems. The results can exceed the gamut and Pantone coverage of established four-color commercial liquid toner systems. This is due to their more colorful pigment particles and more transparent resin coatings. This large gamut and optical color density can accurately meet the specific spot color requirements of manufacturers without the need for pre-coating or premium-priced substrates.

Outstanding Durability

Not to be forgotten, this flexibility in ink formulation also gives Epson a dramatic advantage in print durability, which is critical for applications ranging from office paperwork, to industrial labels, to vehicle wraps that must last several years, and to garments you may wash hundreds of times. Each Epson ink is specifically designed to provide the kind of durability required for particular applications.

Epson's UV ink, for example, has been optimized to retain its original image quality even after extended exposure to the elements and alcohol-based liquids, a necessary performance characteristic for high-quality industrial and consumer labels.

The proprietary Epson technology used in PrecisionCore enables the chemistry required for fast drying pigment ink that provides fade-resistant, water-resistant, and smudge-resistant business documents without premium priced paper. And Epson pigment ink designed to be used in the commercial ticket and label production has the ability to resist alcohol, hand soap, and even methyl ethyl ketone (MEK), the active ingredient used in paint removers.

An internationally recognized durability standard covering the critical labeling of industrial chemical containers is British Standard 5609². BS5609 has stringent durability criteria that include print permanence and abrasion resistance, one example being that prints must remain readable after surviving at least three months immersion in the ocean. Epson printers and pigment inks are the only inkjet printers that meet BS5609³, and in many cases, the ink outlasts the substrate.

In summary, PrecisionCore with Epson inks delivers fast speed, amazing color quality, dark, sharp text, leading durability and fast drying with off-the-shelf media. These newest inks will raise the bar again.

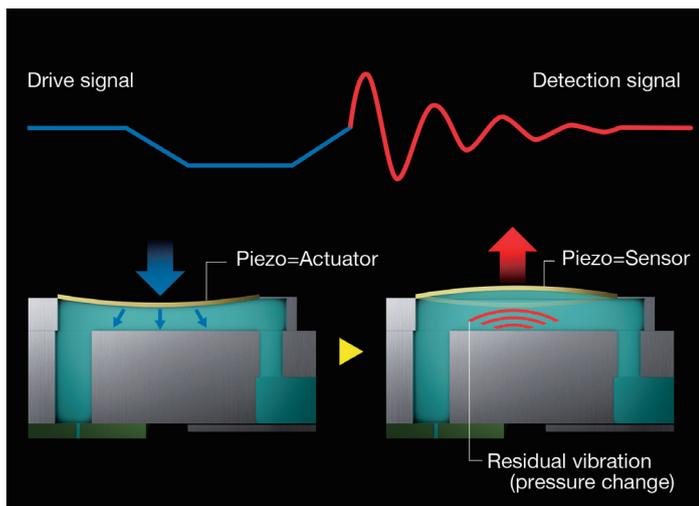
6. Keeping Thousands and Thousands of Nozzles Reliable and Ready

Let's talk for a moment about reliability. Periodic printhead maintenance is an essential part of reliable print quality. PrecisionCore printhead technology is being developed to take full advantage of the characteristics of the piezo at the core to keep working reliably page after page, month after month, year after year. This technology has the potential to be used in a wide variety of Epson printers.

Inkjet systems in general use a range of approaches to ensure the nozzles are able to eject ink without problems. In Epson printers, when the printhead is not in use, it is capped to prevent ink from drying and clogging the nozzles. Capping provides a humid storage environment that keeps the inks liquid in the nozzles at a viscosity that allows them to function immediately when needed. There are also systems to remove the air that has found its way into the ink to prevent air bubbles from forming. And now PrecisionCore introduces a new system that uses the power of the piezo crystal itself to raise reliability, one that is only possible in a piezo printhead.

When voltage is applied to the piezo element, it flexes, acting as an actuator (the pump that ejects the ink). Conversely, when a piezo element is flexed, it actually generates a voltage. Because of this characteristic, the PrecisionCore piezo element can be an extremely powerful ink pump one instant, and a highly-sensitive sensor the next, as shown in the illustration. By using this sensor capability, the piezo element can detect in milliseconds whether it is firing normally, if an air bubble has interrupted firing, or if rising ink viscosity may cause issues, all without having to eject any ink. In other words, it has the ability to self-diagnose its health almost instantly.

Armed with this information, the rest of the system in the future will be able to compensate on the fly for nozzles requiring maintenance at the next convenient stopping point. With PrecisionCore printhead technology, printers will only have to stop when absolutely necessary or convenient.



Nozzle State Analysis

7. PrecisionCore: A Technology for the Future

Incumbent printing technologies face challenges in meeting the demands of modern printing. Today, the competition for customers' print share is defined not only by ink and media pricing, but also by the added-value of convenience, flexibility and speed. Analog presses are fast but are built for high volume duplication, thus creating much inefficiency at lower volume. Office laser printers provide economical black output, but are not very economical for color.

Epson, with its history of innovation and the resources to drive lower and lower cost structures, is uniquely positioned to deliver customer value through the power and flexibility of PrecisionCore. Affordability will continue to improve as economies of scale result from the widespread adoption of PrecisionCore technology in Epson's many serial printheads and fixed linehead printing solutions. With Epson's superior ink flexibility, more and more applications in a wide range of markets will benefit from the technology.

The long-term growth prospects of inkjet, and especially piezo based processes such as PrecisionCore, are extremely bright as the technology is proving ideal for many new and diverse applications. Just as faster processors drove a revolution in computing, faster print chips are now the most important driver of higher productivity and economic output in printing. A new printing era will emerge where color will become affordable and thus ubiquitous. Office managers will be able to enjoy increased productivity and utility from a single printing device. Print service providers will offer faster turn-around, higher volume, and more cost-effective production for items such as signage, labels, and T-shirts. Operations managers in factories will combine the benefits of high-speed inkjets with professional quality for lean manufacturing and just-in-time delivery of customized labels and packaging, eliminating inventory.

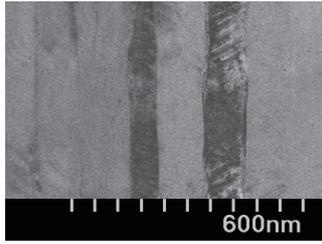
And these are just the printing segments that are immediately evident. The great flexibility of PrecisionCore will enable applications that are yet to be imagined. The ability of PrecisionCore printheads to eject on to a wide range of materials due to its greater active ingredients has already been discussed. Surfaces for new applications can be addressed too, including plastic, glass, textiles, metal, and clay. Need a special ink to adhere to a particular surface? Odds are, PrecisionCore can deliver that ink. Unlike heat-based printing technologies, piezo is able to jet some exotic fluids (pharmaceuticals, conductive materials, etc.) that could be the foundation for tomorrow's breakthrough research. Piezo even allows single-pass micro-deposition of functional fluids used in manufacturing products such as color filters for LED panels, printable electronics and LCD displays.

In summary, years of precision assembly experience, key advances in the piezo material, MEMS process improvements, and commitment to building manufacturing economies of scale have enabled Epson to make PrecisionCore a reality, ensuring that Epson remains at the forefront of printing technology by delivering on the promise of quality output now and into the future.

Tech Focus: **The Technologies behind PrecisionCore**

Thin Film Piezo (TFP)

A piezo crystal has the property that it flexes or changes shape when an electrical voltage is applied to it. This motion is the driving force of the tiny “ink pumps” in every nozzle of Epson’s printheads. In general, the thinner the piezo element, the more it flexes.



Electron microscope image of a PZT piezo crystal cross-section.

Conventional piezo printheads are created by precisely machining pieces of piezo crystal. For its PrecisionCore Thin Film Piezo (TFP) print chips, Epson uses a proprietary process to form a dense PZT piezo crystal element just 1 micron thick on a silicon wafer, resulting in outstanding actuator performance.

Micro Electro Mechanical Systems (MEMS) Manufacturing

Below you can see magnified images of the ink cavities, piezo actuators, and nozzles from the MicroTFP print chip, spaced at 84.7 microns apart. All are created using Epson’s MEMS manufacturing techniques. MEMS technology builds tiny mechanical systems on silicon or glass using semiconductor IC chip fabrication techniques, and is used

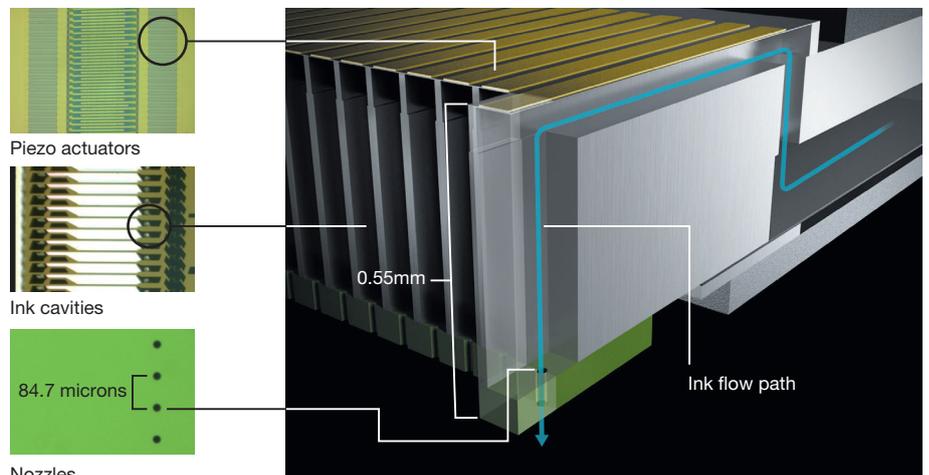
to create accelerometers for automobiles and mobile phones, parts used in hard disk drives, and other devices indispensable in modern society. By merging MEMS processes with its advanced piezo material science, Epson has been able to create microscopic, high-performance actuators and form high-accuracy ink channels, enabling precise, high-speed ink ejection.

Precision Assembly

These print chips are then connected to ink reservoirs, filters and electronics, and finally encased on fully-automated assembly lines featuring Epson’s leading-edge factory automation, with almost no human intervention. Six-axis scalar robots work in unison with proprietary image processing and assembly technology to produce a steady flow of encased chip assemblies, which form the platform for the respective print heads.



Epson robots on the production lines



The key components in the PrecisionCore print chip

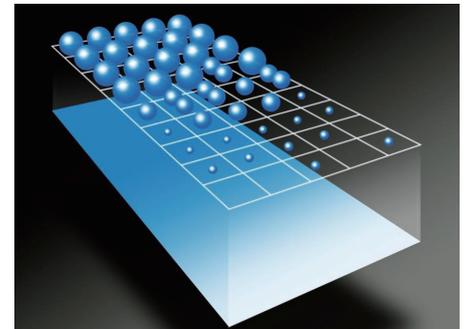
Tech Focus: **Resolution - Not Just Dots Per Inch**

Discussions of print quality have long been characterized by the specification of dots per inch (dpi), but resolution and overall quality have always been more complex than counting dots. All print technologies can produce dots that are so small that they can't easily be perceived. The rest of the print story needs to be examined alongside dpi to understand true print quality. Other factors include levels of grayscale, and how accurately one dot can be placed.

Research⁴ has shown that the levels of grayscale used in an image contribute considerably to its perceived quality, more so than pure dpi resolution. Take a look at the graphic to the right, keeping in mind you would be unable to see these individual dots without magnification. Each of the dot sizes ejected by the PrecisionCore head represents an available level of grayscale, with the smallest dots providing gradation equivalent to a much higher resolution. For this reason, dpi by itself has become an obsolete way to compare print systems. In fact, Epson's reputation for the best output quality has always had more to do with superior color

gamut and gradation than raw dpi.

Dot precision or accuracy is another important factor, especially for detail, as additional dots add little value if their location or form cannot be controlled. Accuracy, as used here, refers to the ability not only to place a dot in a desired location, but also to the characteristics of the dot itself. Is it uniformly rounded? Can you maintain control of its size across a line? A page? A hundred pages? A thousand pages? PrecisionCore shines by producing incredibly precise, variably sized dots repeatedly and reliably.



How variable dot sizes produce smoother output

Tech Focus: **PrecisionCore: An Ink Chemist's Best Friend**

Resolution and precision are table stakes for printing, but there is more than that to output quality. In desktop printers, ink can contain some twenty different ingredients, each playing an important role in creating the final print. PrecisionCore's micro-mechanical firing element avoids the material limitations faced by heat-based systems, enabling Epson's ink chemists to select from a wider range of critical materials, and to use them in higher concentration. This delivers a number of benefits.

First, it allows for more colorful and durable ink formulations. Ink formulations that contain higher concentrations of colorants and binders than heat-based inkjet systems means brighter, more vibrant, and more durable output on photos, documents, labels, textiles, and even dye sublimation transfers to everyday objects, such as coffee mugs. It's no surprise one of Epson's inks is called DURABrite®, in testimony to its durable and bright colors.

Second, it also allows printing on a much wider range of substrates. Epson inks contain functional additives with properties that permit greater substrate addressability, enabling inks to adhere to a wider range of materials. Carrier flexibility of the PrecisionCore print chips is another factor that contributes to media flexibility. PrecisionCore can print with aqueous pigment and dye, eco-solvent, resin, sublimation, oil-based or UV curable inks. This means Epson printers can be designed to print on anything from plain paper to glossy labels to synthetics, and from three-point text fonts to large format signage due to the unique ink chemistry.

To summarize, PrecisionCore enables output that has superior color with dark blacks, because of its ability to deliver more colorant per dot volume, and more durable output because of its ability to deliver inks with a higher percentage of binder.

Sidebars **The Office Printer Reinvented: Laser-like Text, Vibrant Color, Durability**

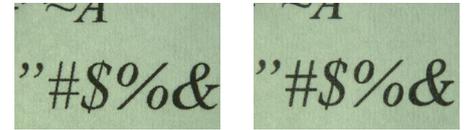
The economics of laser printers will be challenged by the emerging generation of inkjet printers that combine laser printer duty cycles and text quality with inkjet color and efficiencies at ever higher speeds.

Let's take a moment to consider how PrecisionCore specifically stacks up against the current standard for office printing, the laser printer. Laser printing (also known as dry toner electrophotography or dry toner EP) has been the norm for office printing since the 1980s. Dry toner EP uses electrical charges to pick up powdered toner which is then heat-fused to the surface of the paper. It has long set the standard for text quality as dry toner EP has good optical density and edge sharpness, these perhaps being the most significant components of how text quality is perceived. This text appearance is achieved largely because the electrical charges that hold toner particles tend to cause two closely spaced toner spots to merge. This smooths the edges and causes the dots making up a text letter to clump together.

Epson inkjet printers, on the other hand, can place variably sized dots of a range of colors, enabling it to produce rich, vibrant colors in output such as photos. Sky colors and skin tones with fine gradations can also be reproduced. However, when printing small characters or lines on normal paper, ink bleed and insufficient dot placement accuracy historically meant the edges of the text appeared more ragged than those printed with a laser engine, so for many years inkjet was thought to not be suitable for business documents. Now, that gap is disappearing.

Below is a comparison of the output of a PrecisionCore powered desktop printer with that of an Epson laser printer. As PrecisionCore printheads are able to place almost perfectly round ink drops more accurately than ever before, the difference with laser-printed, text-heavy business documents is practically indistinguishable to the naked eye. At the same time, Epson prints give you the "jump off the page" business black and

color pigment ink.



PrecisionCore powered inkjet print sample (12 point)

Epson laser printer print sample (12 point)

In addition to quality, business documents printed with PrecisionCore and Epson's business inks deliver durability that exceeds that of laser printed pages, all without special paper formulations. Spill a little water, use your highlighter, and then give it a close inspection. When highlighting a document printed on a laser printer, the ink from the pen will be repelled, but not with Epson pigment inks for business, and the characters will not become blurred either. Also, as with laser printers, the text will not disappear when the document is rubbed or abraded. In the office, documents are treated in many ways; written on, folded, and pencils marks are erased. Do all the things that you would do with a laser printed page to a PrecisionCore printed page and you'll find that the laser printer no longer has any durability advantage.

Epson's no-heat technology also saves power by eliminating the fuser required for toner-based printing technologies, resulting in up to 70% less energy consumption. Laser printers generally also have a larger consumables footprint, requiring periodic replacement of the drum, transfer belt, and fuser in many cases. Add in the faster start-up time yielded because a PrecisionCore powered printer does not need to warm up like a laser printer does when it powers on or awakens from sleep and it is only natural that the time for inkjet to take its place in the laser-dominated office has arrived.

Appendix 1 PrecisionCore Print Chip Specifications

	TFP print chip	MicroTFP print chip
Technology	Thin Film Piezo inkjet technology	
Print chip construction	MEMS (Micro electro mechanical system) All-silicon ink path and nozzle plate	
Compatible ink types	Aqueous, solvent, resin, UV curable	
Operating frequency	Up to 50kHz	
Drop size	1.5 – 32.5 picoliters (Multi drop size technology)	
Dimensions(L x W)	29.7 x 8 mm	38.5 x 6.8 mm
Nozzle line length	25.4mm (1 inch)	33.8mm (1.33 inch)
Lines per print chip	2	2
Nozzles per line	360	400
Nozzles per print chip	720	800
Nozzles per inch	720	600
Nozzle pitch per chip (2 nozzle lines)	35.2µm (720dpi)	42.3µm (600dpi)

Endnotes

1. Source: Pira International, Infotrends
2. BS-5609 is a standard developed to ensure the durability of labeling for dangerous goods being shipped by sea. If an accident at sea should occur, the responders need to easily identify the contents of these goods. The Epson B510, TM-C3400 and GP-C820 have all been certified to conform to the BS-5609 standard.
3. Epson DuraBrite® inks with Neenah KIMDURA® ink jet media.
4. Farrell, J.E (1997). Grayscale and Resolution Tradeoffs in Photographic Image Quality. SPIE Vol. 3016
5. Compared to best-selling, color multifunction laser printers in the US market priced at \$399 or less as of April 2012. Actual power savings will vary by product model and usage.

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