Technical white paper

HP PageWide Technology

Reinventing expectations

Business moves fast. Professional impressions are paramount. Exceptional office printing helps set the pace, pushes projects forward, makes work teams more efficient, and improves the bottom line.

Table of contents

Unbeatable value. Unparalleled speed.

HP PageWide Technology leverages the proven, advanced technology developed for HP's multimillion-dollar Web Press digital printers, and delivers a new class of desktop printers and MFPs—reinventing the affordability and performance of business printing.

- Best-in-class print speeds[1]—up to 75 pages per minute (ppm) (Enterprise 500 series)
- Fast single-pass, two-sided scanning (MFP devices)—up to 70 ipm[2,3]
- Less energy than lasers in its class[4,5]
- Durable documents that are water-, smear-, fade-, and highlighter-resistant[6]
- Fewer replaceable parts than most lasers[7]
- Job concurrency—scan, copy, or fax[8] while someone else is printing, and keep work moving (MFP devices only)

How HP PageWide Technology achieves breakthrough speed

HP PageWide printers and MFPs print across an entire page in a single pass. 42,240 tiny nozzles on a fixed printhead eject ink in precisely the right location on a moving sheet of paper. Because the paper moves and the printhead does not, HP PageWide printers are quiet and dependable—offering laser-fast print speeds and a rapid first page out (FPO).

Key design elements result in high print quality, speed, and reliability:

- A PageWide array of 42,240 nozzles produce ink drops with uniform drop weight, speed, and trajectory
- Each of the four colours are allocated 10,560 nozzles that are nominally overlapped, resulting in 1,200 nozzles-per-inch native resolution
- HP pigment inks provide controlled ink-paper interactions: high black and colour saturation, dark, sharp, crisp text, and rapid drying
- Precise paper motion enables dependable print quality and reliable operation
- Automatic nozzle health sensing, active and passive nozzle substitution, and automatic printhead servicing enables consistent print quality

How ink printing works

The basic elements of ink-based digital printing are colourants, processes for transferring colourant to the paper, and the paper used for printing.

HP pigment inks—a recipe for quality

Colourants form the image on paper by reflecting light at specific wavelengths to produce distinct colours. Colourants can be made of dyes, pigments, or a mixture of both.

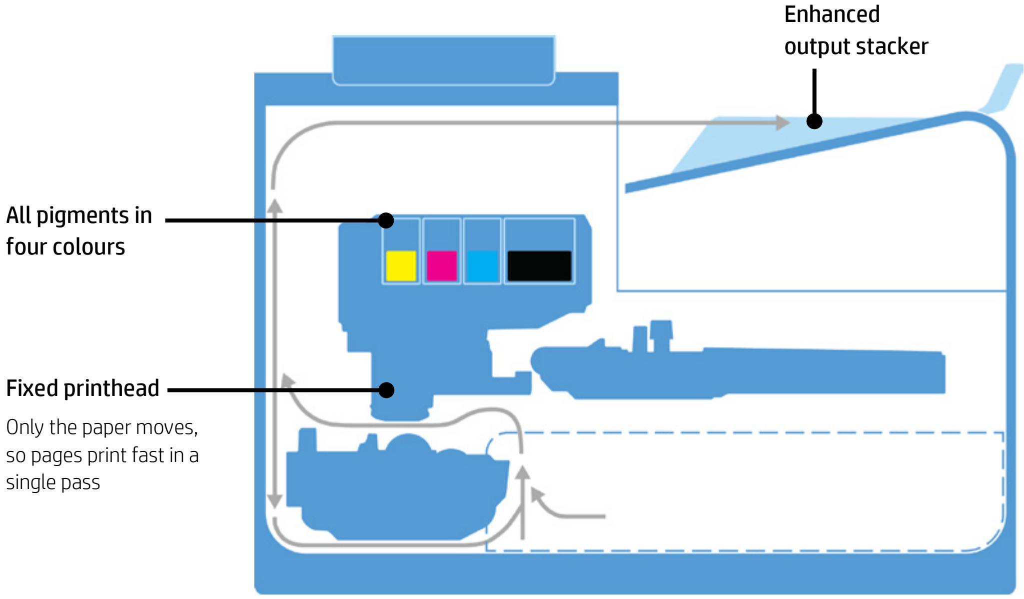
Dyes are composed of individual molecules, whereas pigments are tiny coloured particles whose diameter is about a wavelength of visible light. Both can produce bright, colourful images. However, pigments offer superior colour saturation, black density, fade resistance, and smear resistance (for example, from water and highlighters) on office papers and coated brochure papers. These attributes make pigments the colourant of choice for HP LaserJet toners and for the HP inks used in HP PageWide printers.

In order to produce colourful graphics and images along with sharp, crisp lines and text, the colourant must remain at or very near the paper surface. If colourant moves across the surface or penetrates too deeply into the sheet, lines and text won't be sharp, blacks won't be dark, and colours won't be vivid. To achieve high print quality, colourants must rapidly immobilise in a thin surface layer immediately after they reach the paper—a primary factor in the high quality produced by HP LaserJet printers and HP PageWide printers.

HP has always been known for the high quality of their inks and toners. These PageWide printers use new and improved pigment inks that build on that heritage.

Storing and delivering the ink

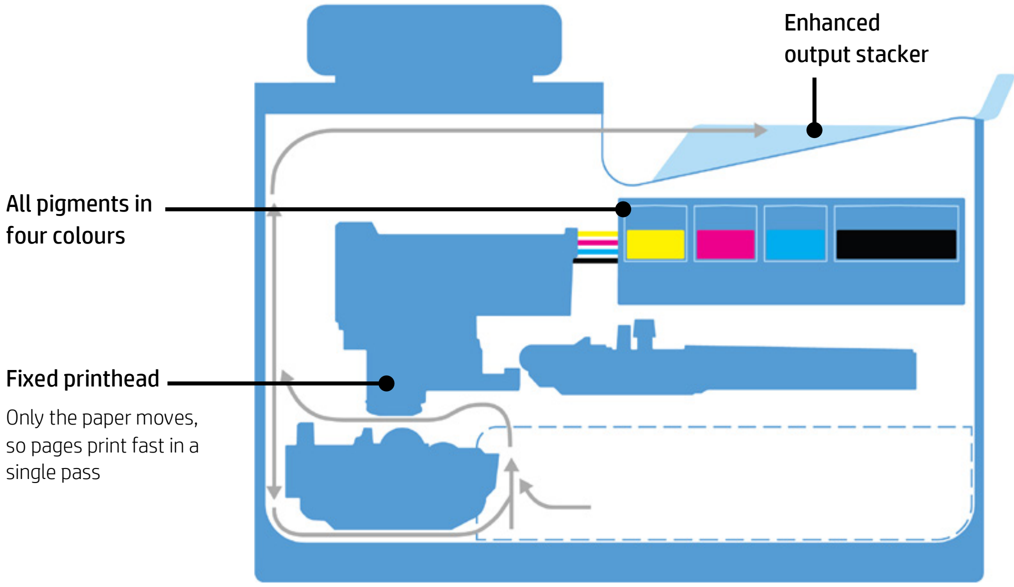
HP PageWide 300 and PageWide Pro 400 series integrated printhead and delivery system



In the first generation of PageWide printers, the ink storage was connected to the print nozzle system. This is referred to as on-axis technology.

Figure 1. On-axis technology

HP PageWide Enterprise 500 series integrated printhead and delivery system



With the latest generation of HP PageWide printers, the ink storage location is separate from the printhead—enabling greatly increased ink storage capacity. The printhead still moves up for servicing, however, the ink storage remains stationary. This new generation of printheads is referred to as off-axis technology.

Figure 2. Off-axis technology

Moving the ink from printhead to paper

Unlike HP LaserJet toners, which are dry powders, inks are liquids during storage and delivery to the paper, and they behave like liquids for a short time on the paper surface.

Inks are composed of colourants and a clear liquid, called the "ink vehicle," that carries the colourants to the paper. The ink vehicle in HP pigment ink is primarily water, but it also contains ingredients required for consistent, reliable drop ejection and for controlling interactions between the ink and paper.

Ink travels to the paper surface in tiny, 8-picolitre drops. There are one trillion (1,000,000,000,000) picolitres in a litre and a gram of ink yields about 125 million 8-picolitre drops. The printhead ejects drops one at a time through individual nozzles, and each drop must emerge at a consistent weight, speed, and direction to place a correct-sized ink dot in the correct location.

An HP Thermal Inkjet printhead is approximately 50 µm thick—about the size of a human hair—and has no moving parts. Nothing moves except the ink itself. Inside the printhead, shown by the cutaway diagram in Figure 3, an electrical pulse of about one microsecond—one millionth of a second—heats a tiny resistor in the drop generator—a three-sided chamber with a refill channel and nozzle—that is filled with ink. A thin layer of ink vaporises to form a bubble that expands to propel a drop out of the nozzle at approximately 10 metres (33 feet) per second. The bubble acts like a tiny piston, rising out of the floor of the chamber to push ink overhead through the nozzle. As the bubble collapses, after about 10 microseconds, it breaks the ink stream into a droplet and draws fresh ink into the chamber, refilling it for another cycle. (The flow of ink is shown by the black arrows in Figure 3.) After leaving the printhead, the ink drop flies about 1 mm to produce a dot in a precise location on the paper. This process can repeat tens of thousands of times per second in each drop generator.

Once on the paper, pigments must quickly immobilise to produce sharp text and lines and to achieve high colour saturation and black optical density. HP pigment inks quickly separate the pigments from the ink vehicle to prevent colour and black inks from mixing at the boundaries of lines and characters. The printed image dries as volatile components of the ink vehicle (primarily water) evaporate and leave the pigments behind.

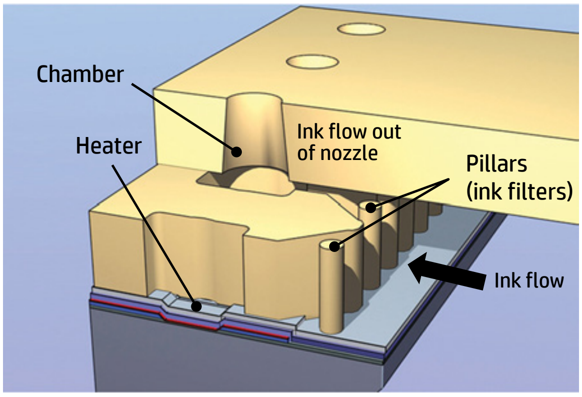


Figure 3. Cutaway view of an HP Thermal Inkjet drop generator

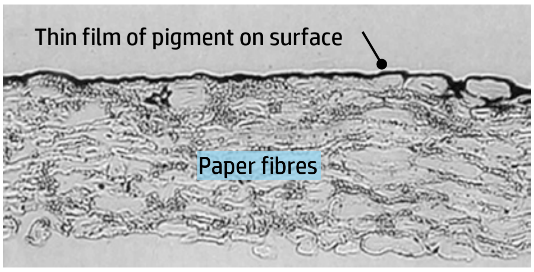


Figure 4. HP pigment ink on HP Multipurpose Paper with ColorLok® Technology

Figure 4 shows a cross-section view of HP pigment ink on HP Multipurpose Paper with ColorLok® Technology. A thin, conformal film of pigments is seen on the paper surface along with the internal structure of the paper. The chemistry of ColorLok® Technology holds the pigments at the paper surface, enabling HP pigment inks to deliver colour and black imaging performance comparable to HP LaserJet toners.

Building a PageWide printhead

HP Scalable Printing Technology

The dependable print quality, speed, and reliability of HP PageWide printers is made possible by HP Scalable Printing Technology (SPT)—the latest generation of HP Thermal Inkjet technology that employs ultra-precise and proven materials, design rules, and manufacturing processes.

SPT brings to printhead manufacturing the benefits of large-scale, precision processes developed for the production of integrated circuits. With SPT, all parts of the printhead, from thin-film integrated circuits to thick-film fluidic structures, are defined using a process known as photolithography, which can define very small structures. The ink passages, chambers, and nozzles in SPT printheads are produced with sub-micron precision to deliver every drop with uniform volume, speed, and trajectory for consistent image quality.

Figure 3 presents a schematic, cutaway view of an SPT-based Thermal Inkjet drop generator. On a silicon substrate, thin-film layers produce integrated electronic circuits and the resistors (or heaters) used to eject drops. A feed slot fabricated through the silicon (seen at the lower right) provides the ink supply to arrays of drop generator chambers placed on either side of the feed slot.

The PageWide printhead is designed to last the lifetime of an HP PageWide printer, and its reliable operation depends on robust contamination resistance. SPT enables the placement of tiny pillars (shown in Figure 3) that act as an ink filter, forming a barrier to particles that could enter and clog the drop generators.

The drop generator chamber and the orifice (nozzle) plate are made of the same photo-imageable polymer (shown in a tan colour). To give a sense of scale, the thickness of the chamber and orifice plate is less than a human hair (~50 microns). This integrated structure is built up from the silicon through several steps involving polymer deposition, exposure, and development. To help ensure a long service life, the thin-film layers on the silicon substrate, ink feed slot, chamber, and orifice material all have high resistance to chemical interaction with the inks.

A PageWide printhead

HP's on-axis, PageWide, 4-colour writing engine assembly is shown in Figure 5. Ink cartridges for black, cyan, magenta, and yellow inks plug into ink fittings at the top of this assembly that provides pressure regulation and filtration for each ink. The writing engine assembly also senses when the cartridge is running low or out of ink. Cartridges can be changed easily and there is an informational animation on the printer control panel describing this process.

Figure 5. On-axis PageWide writing engine assembly

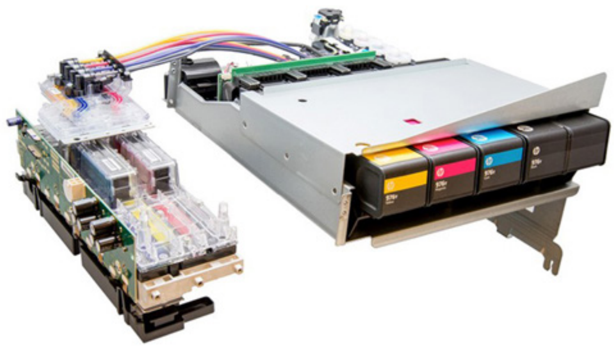


Figure 6. Off-axis PageWide writing engine assembly

Figure 6 shows the off-axis writing engine assembly. The supplies are separated from the nozzle assembly and moved into a larger area, allowing for much higher supply capacity. There is also an intermediate reservoir that allows the printer to continue printing up to 500 sheets after the cartridge has run out.

Both printheads have ten HP Thermal Inkjet chips, called dies,[9] placed upon rigid, dimensionally stable, injection-moulded plastic carriers. The carriers precisely align each die in the array and provide interfaces for the ink.

Table 1. Ink cartridge yield increases for off-axis printheads

Ink cartridge yields		On-axis printhead	Off-axis printhead
Black (K)	Colour (C,M,Y)		
3,500	3,000	✓	✓
10,000	7,000	✓	✓
14,000	13,000	Not available	✓
20,000	16,000	Not available	✓

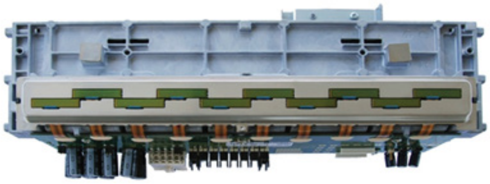


Figure 7. PageWide writing engine assembly, bottom view

Figure 8. Detail of an HP Thermal Inkjet die

Figure 7 shows a bottom view of the writing engine assembly with the printhead visible.

Figure 8 shows a close-up view of a die and its neighbour. Each die has 1,056 nozzles for each of four ink colours, totalling 4,224 nozzles per die and 42,240 nozzles on the printhead

The nozzle array for each ink is formed from two columns of drop generators on either side of an ink feed slot fabricated through the die (see Figure 7). The polymer material that forms the orifice plate and drop generator chambers is transparent, so the drop generator chambers and the surface of the die with its four-ink feed slots are visible in Figure 7.

Figures 7 and 8 show the stainless steel shroud that seals around the dies. The shroud provides a flat surface for the service station to cap (seal to prevent ink from drying) and wipe the printhead.

Electrical connections are made by bonding a flexible circuit to interconnect pads on the sides of each die. These bonds are protected by the (blue) bead of epoxy seen in Figure 8. The flexible circuit carries signals and power between each die and a printed circuit board on the writing engine assembly (seen in Figures 5 and 7).

In addition to the drop generators, each die has integrated electronics for signal processing and power control. Only ten electrical interconnections[10] to each die are needed to operate 4,224 nozzles. Data rates into each die can exceed 100 megabits per second.

As seen in Figures 7 and 8, dies are staggered, and overlap by 30 nozzles at each end.

For the dot rows in the overlap zones, the printhead uses nozzles on both dies to suppress any print artefacts at the die boundaries.

The print swath spans 217.8 mm (8.575 inches), allowing HP LaserJet margins[11] on US Letter A and US Legal (8.5 inches) and ISO A4 (8.27 inches) formats. For each of the four colours, the print swath is 10,290 dot rows spaced at 1,200 dots per inch across the printhead.

Managing 42,240 nozzles

HP PageWide Technology periodically tests the performance of all 42,240 nozzles on the printhead to help maintain dependable print quality. This automatic process finds nozzles that are not performing within specifications, and also checks each nozzle frequently so that it catches and corrects any failures that could affect print quality.

HP PageWide printers use optical sensors to calibrate the printhead, measure nozzle performance, and monitor paper motion. These sensors are placed on a small carriage that scans across the paper and printhead. A paper sensor scans printed diagnostic test patterns, and the writing system controller uses this information to electronically compensate for die-to-die alignment tolerances and variations in drop volume that could produce visible print artefacts. This sensor also detects the edge of the sheet as it moves into the print zone. A printhead sensor, developed specifically for HP PageWide printers, measures individual drops in flight as part of a system that provides robust print quality by substituting good nozzles for those that do not meet operating specifications.

PageWide printing arrays, whether in a toner- or ink-based printer, can produce streaks along the paper axis when dots are missing or misplaced. With ink, a bad nozzle typically produces a light streak that is visible in the dark and mid-tone areas of monochrome images; a light or coloured streak may appear in colour graphics and images.

With 1,200 nozzles per inch across the page, missing or misplaced black dots from one or more isolated bad nozzles will generally have little or no visible effect on black text. Because text is printed at high density, the spread of ink into the missing dot row from neighbouring dots will suppress a streak.

The problems with bad nozzles can be suppressed by nozzle substitution, by which the immediate neighbours of a bad nozzle take over printing its dots. For the printing system to perform automatic nozzle substitution, it must determine precisely which nozzles are good and which are bad.

There are many challenges to measuring individual ink drops in-flight from a PageWide printhead:

- Each drop is less than 25 microns (0.001 inch) wide, and drops move at about 10 metres (33 feet) per second
- There are four nozzle arrays on each die. Since the dies are staggered on the printhead, the arrays of nozzles are positioned at different distances from the sensor
- The measurement system must fit into a confined space close enough to the printhead to measure individual drops
- The sensor must be highly immune to stray reflected light and electrical noise
- Drop detection must have little impact on printer productivity[12]

For HP PageWide printers, HP developed a technology called Backscatter Drop Detection (BDD). BDD employs innovative optics and multiple photodetectors along with advanced analogue and digital signal processing. Unlike other optical methods, where a drop passes between a light source and a detector, BDD works by detecting the light that is backscattered (reflected) by a drop passing through a focused light beam. The Backscatter Drop Detector can test several hundred nozzles per second.

BDD is shown schematically (with light rays traced) in Figure 9. The BDD module consists of a housing (not shown), lenses, a surface-emitting diode (SED) light source indicated by the magenta rays in Figure 9, and photodetectors behind aperture plates.

The SED emits a beam of light through a projection lens, and four imaging lenses focus backscattered light from the drops onto the photodetectors. With staggered dies on the printhead and multiple columns of nozzles per die, drops are emitted at different distances from the detectors in a sample zone that is about 10 mm (0.4 inches) deep. A backplane behind the printhead reduces unwanted reflections of light, which improves its ability to detect the very weak signal produced by backscattered light. After a backscattered signal is processed by analogue and digital circuits, algorithms assess each nozzle's fitness to print.

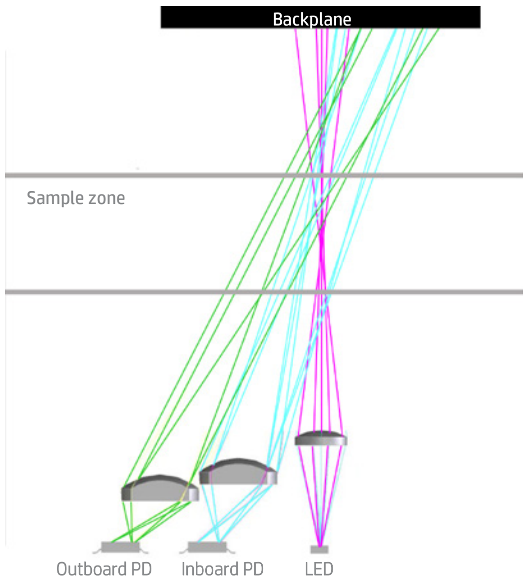


Figure 9. Schematic of Backscatter Drop Detection

Nozzle substitution

HP Thermal Inkjet's high drop rates and high nozzle density provide both active and passive nozzle substitution to suppress the effects of failed nozzles. This is one of the keys to the excellent print quality achieved by HP PageWide printers.

Figure 10 shows examples of nozzle substitution in a 1,200 x 1,200 grid for a passive case and two active cases. For orientation, dot rows run down this page, designated by the letters "a" through "h" in this figure. The nozzles out in this example are "b" and "e", "f" and "g", shown by the empty small black dots representing drop generators. Good black and colour drop generators are shown by the small coloured dots. Dot columns run across this page, and are associated with nozzle locations on the printhead. The paper moves down the page in this figure.

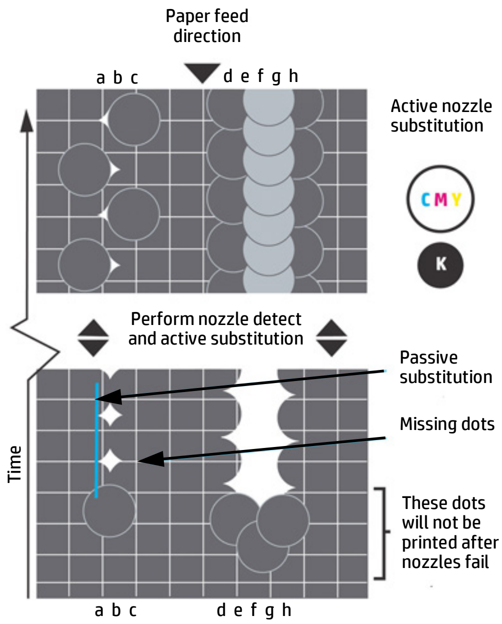


Figure 10. Schematic of nozzle substitution

The choice of grid points that receive ink drops to produce a solid black area fill, as well as the selection of nozzles to substitute for a failed nozzle, use sophisticated algorithms to control ink load, minimise image artefacts (such as grain and banding), and implement active nozzle substitution. Figure 9 is highly schematic and doesn't take into account the full extent of dot spread, which will substantially fill in the white spaces as shown to further improve the results of error hiding. But, to illustrate basic principles, Figure 10 is faithful to the actual processes used for nozzle substitution.

Passive nozzle substitution

This feature makes direct use of HP Thermal Inkjet's high nozzle density: if one nozzle fails, the surrounding nozzles compensate. With 1,200 nozzles per inch, there are two nozzles for each ink colour that can print within a 600 x 600 grid,[13] and neighbour nozzles are at most 21 μm (1/1,200th of an inch) from the affected dot row.

Passive substitution is shown schematically for the nozzle printing column "b" in Figure 10. Nozzle failure could potentially produce the white streak shown in the lower half of the figure. But, with ink spread from the neighbouring dots, the white streak is substantially smaller than a full 1,200 x 1,200 square. In fact, dot spread may completely close up the white space making a single nozzle failure practically invisible. In any case, this defect will usually be difficult to see in normal-size text. After this nozzle failure is detected, active nozzle substitution is employed for row "b" in the upper half of the figure.

Active nozzle substitution

A nozzle-out lookup table compiled from the results of several BDD measurements over time is used for active nozzle substitution. Some nozzles may remain out while others recover after printhead servicing. The lookup table is processed to select nozzles that can take over printing from a failed nozzle. This may require double the drop rate from the substituting nozzles. In some cases, drops of other ink colours can be substituted in the same and neighbouring dot rows. In this way, active nozzle substitution can effectively handle situations where two or more adjacent nozzles have failed.

Figure 10 shows two cases of active nozzle substitution: one black nozzle out (row "b") and three adjacent black nozzles out (rows "e", "f", and "g").

For a single black nozzle out in row "b", active substitution prints dots using neighbouring black nozzles from rows "a" and "c". The upper half of Figure 10 shows this schematically with black dots. Alternating dots between rows "a" and "c" reduce the visibility of the white space and break up a dark line that might otherwise be visible if dots were substituted only on one side of row "b".

If three or more adjacent nozzles are out, active nozzle substitution uses both black and colour inks. For example, consider black nozzles out in rows "e", "f", and "g" in Figure 10.

In the lower half of Figure 10, having three adjacent empty dot rows could produce a visible white streak as shown. Three adjacent dot rows are too large a gap to be effectively handled by passive nozzle substitution. After the failures are detected and processed into the nozzle-out lookup table, active nozzle substitution is applied as shown in the upper half of the figure. Good neighbouring black dots are substituted in rows "d" and "h". Row "f" is printed with composite black dots, indicated schematically by dots with a dark grey fill, from the printhead's cyan, magenta, and yellow nozzles that print in row "f". (The printed dots are not actually grey—grey is shown only for the purpose of illustration).

Printhead servicing

Periodic printhead servicing is an essential part of reliable print quality. It keeps good nozzles working and may be able to recover bad ones. HP PageWide printers feature a built-in service station cassette that performs four key functions: printhead capping, nozzle conditioning, nozzle plate wiping, and ink containment used for servicing. While printhead servicing is automatic, a user may initiate a printhead cleaning cycle, if required. Figure 11 shows the cassette and calls out the key components.

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 drops to be ejected. The cap presses against the printhead's stainless steel shroud and seals around the dies without touching them.

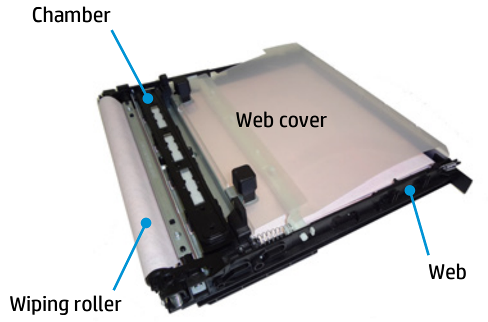


Figure 11. Printhead service station cassette

Nozzle conditioning refreshes the ink in each nozzle. This allows the printhead to eject drops within mass, speed, and trajectory specifications. Due to the loss of volatile ink components (mainly water), each nozzle periodically ejects a few drops through the print platen to purge ink that has become too viscous to meet print quality specifications and could clog the nozzle. Drops used for nozzle conditioning are captured below the print platen on a spit roller that indexes slowly with paper motion. Ink is removed from this roller and stored in a chamber inside the duplexing unit. Since a small amount of ink is used for nozzle conditioning, and it evaporates over time, the chamber capacity is designed to last the lifetime of the printer.

In the service station cassette, a circulating web of absorbent material stores used ink and provides a means of wiping the printhead nozzle plate. Because most of this ink eventually evaporates, the web dries between wiping and servicing events and is reused. The service station cassette is designed to last the life of the printer, but is replaceable under certain conditions.

The web advances automatically during service functions. During servicing, the writing engine assembly automatically lifts away from the platen, allowing the service station to move under the printhead. For wiping, the web advances over a spring-loaded roller (see Figure 11) that gently presses it against the nozzles. This removes paper dust and any ink accumulation. The cassette then advances further under the printhead to engage the cap.

Ink and paper, working together

PageWide printing requires special ink formulations and highly controlled interactions between ink and paper to achieve high print quality in a single pass. HP pigment inks produce superb results on ColorLok® papers.

HP pigment inks

HP ink chemists formulated HP pigment inks for HP PageWide printers to meet the demanding requirements of dependable, high-quality, fast, single-pass printing:

- Nozzle arrays for each colour are placed close together on each printhead die, so inks must resist mixing and cross-contamination during operation, storage, and wiping.
- Black inks must produce high black optical density in a single pass.
- Single-pass, high-speed printing requires that the inks resist mixing at colour-to-colour boundaries in the image while still liquid. However, inks must be able to produce smooth and saturated secondary colours (such as reds, greens, and blues) in a single pass when different inks are printed dot-on-dot and wet-on-wet.
- The printer must quickly control paper curl and cockle (puckering) to prevent paper jams, and must quickly immobilise pigments to prevent ink from smearing during paper transport and to prevent ink transfer (sheet to sheet) in the output tray.

Papers with ColorLok® Technology

Liquid inks undergo complex physical processes and chemical reactions on the paper surface. Therefore, ink and paper must work together as a system to deliver the best results.

Substantial advances in both ink- and toner-based printing technologies have driven high demand for office papers that offer enhanced print quality with reliable and consistent results for both ink and toner. ColorLok® Technology delivers these benefits on plain papers used for office printing.

ColorLok® papers have special additives to rapidly separate pigments from the ink and immobilise them on the paper surface. For ink-based printing, ColorLok® papers deliver higher print quality with bolder, darker blacks, and richer, more vibrant colours.[14] Ink dries faster, which means pages can be handled without smearing right from the output tray. All these benefits also apply for recycled papers with ColorLok® Technology. ColorLok® papers are available worldwide from leading paper suppliers.

HP recommends ColorLok® papers for best printing results. To learn more about the benefits of ColorLok® Technology, visit colorlok.com.

Moving the paper

To compete with colour laser printers in small work team environments, HP PageWide printers need a compact, reliable paper transport that produces fast, face-down, correct-order output with built-in duplexing. HP designed a new paper transport to meet the needs of PageWide array printing. Figure 12 shows a cross-sectional view of the key components. A single sheet of paper, shown by the green arrow, moves from right to left in this view.

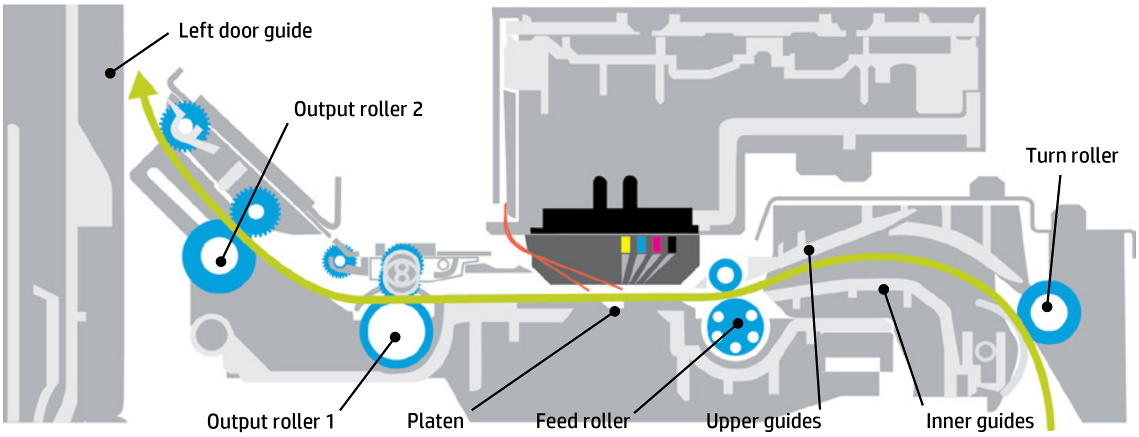


Figure 12. Cross-section of the paper transport system

A sheet printed on one side (simplex) moves up against the left door guide, passes under the writing system assembly, and exits face down to the output bin. A duplex-printed sheet moves up against the left door guide, then reverses and passes under the duplexing unit (not shown), following the same path taken by sheets coming from the multipurpose tray (tray 1). This design efficiently integrates duplexing and multipurpose tray functionality into the paper path.

The HP PageWide paper transport effectively delivers reliable paper pick, low jam rates, and continuous and accurate movement of the paper in the print zone. Sheets are printed, duplexed, and delivered to the output tray without smearing ink.

The HP PageWide paper transport incorporates a number of innovations that enable cost-effective, precise paper motion control. These include:

- A gear train with precision-matched pitch diameters
- Precision bearings
- Servo-controlled overdrive of specific rollers
- Precision roller diameters
- Star wheels
- Drive shaft biasing to prevent backlash

Users have come to expect low rates of pick and jam failures from HP LaserJet solutions. HP adapted paper pick mechanics and paper supply tray spring-plate designs from high-end HP LaserJet printers to give HP PageWide printers pick and jam failure rates measured in single events over several thousand pages—similar to HP LaserJet rates.

In cut-sheet paper handling a sheet's leading or trailing edge is almost always moving into or out of a set of elastic rollers, and this can disrupt smooth paper motion. If not properly controlled, edge transitions produce paper velocity variations in the print zone that can appear as dark or light bands and irregular lines. The paper transport in HP PageWide printers is designed to effectively handle edge transitions and maintain controlled paper motion through the print zone.

Uncontrolled movement of paper along any axis of motion or rotation translates into dot placement errors on the sheet. Motion in the paper feed direction and movements that affect printhead-to-paper spacing are of particular concern. Multiple hold-down features are incorporated into the paper transport design to stabilise and constrain the paper.

A dual reverse-bow is introduced in the paper on the input and output sides of the paper transport, as seen in Figure 12. This effectively holds paper against the platen and prevents the paper's leading and trailing edges from lifting while entering and exiting the print zone.

The high rate of ink application on paper from a PageWide array means that the ink is still wet when it leaves the print zone. Damp paper loses stiffness, so it must be handled carefully to avoid smearing ink. The paper path design addresses issues associated with handling a damp sheet by guiding the paper with star wheels—thin, metal gears that only touch the paper with sharp points, so they can roll over wet areas without leaving ink tracks. Although HP has used star wheels in printers for many years, they have not been used extensively to drive damp paper around tight corners inside a printer. The paper path for HP PageWide printers uses more than 300 star wheels to precisely control paper motion.

HP PageWide printers have an active flap near the output tray that controls curl as the printer ejects paper. The flap is closed when the printer is not printing. It opens partially when printing with high ink densities in dry environments—when more curl might occur— and opens fully under other conditions to control moderate curl.

Paper trays and capacities

Flexible paper input options let you print in high volumes. The new HP PageWide Pro series has two more trays compared to the HP PageWide Pro X series, for a maximum input capacity of 1,550 sheets. The new HP PageWide Enterprise series offers a 3 x 500 feeder/stand accessory for an input capacity of up to 2,050 sheets.

The HP PageWide output system incorporates a number of innovations that enable precise paper eject and tidy stack. These include:

- Adjustable paper guides hold printed pages on two sides for neat stacking in the output tray
- A stack extension that accommodates letter- and legal-sized media helps direct the media
- Media exits the MFP at a controlled, slower speed than it moves through the paper path to prevent it from overflowing during high speed printing

Table 2. Paper handling accessories, HP PageWide Pro and Enterprise

HP PageWide Pro	HP PageWide Enterprise
Max input capacity: Up to 1,550	Max input capacity: Up to 2,050
50-sheet multipurpose tray 1	50-sheet multipurpose tray 1
500-sheet main input tray 2	500-sheet main input tray 2
Optional 1 x 500-sheet tray 3	Optional 1 x 500-sheet tray 3 (standard on 556xh)
Optional 2 x 500-sheet trays with mobile cart	Optional 3 x 500 feeder/stand

Achieving high print speeds and fast first page out

The data processing architecture for HP PageWide printers was designed to support the high printing speeds from the PageWide printhead as well as provide fast first page out.

Throughput of HP PageWide printers in General Office and Professional (default) modes are shown in the table below.

Table 3. HP PageWide printer speeds, PageWide Pro and Enterprise

Quality Mode	Simplex (pages per minute)	Duplex (pages per minute)
General Office	Up to 75[1]	Up to 38
Professional—ISO (default)	Up to 50	Up to 25

First page out (FPO) time—measured from the moment of selecting "Print" to the drop of the first page into the output tray—depends on a number of factors including host processor speed, interface type, network speed and network traffic, document complexity, and printer status (active, standby, sleep).

- HP PageWide Pro devices have an FPO as fast as 6 seconds (black) and 6.5 seconds (colour) from ready (HP PageWide Pro 477 and 577 MFP series).[15]
- HP PageWide Enterprise devices have an FPO as fast as 7.4 seconds (black); 8.9 seconds (colour) from ready (HP PageWide Enterprise Color 556 series and HP PageWide Enterprise Color MFP 586 series).[16]

Conserve resources—save energy and money

Efficient, reliable HP PageWide Technology is engineered to use less energy than lasers.[4] By eliminating the fuser required for toner-based printing technologies, it saves significant power. HP PageWide devices are ENERGY STAR® certified and lead the competition in energy efficiency.[4,5] They offer users low operating and standby power requirements, a low Typical Energy Consumption (TEC), and HP Auto-Off Technology that automatically turns the device off when you don't need it.[17,18]

Summary

HP PageWide Technology delivers a new class of desktop printers and MFPs—reinventing the affordability and performance of business printing. The devices offer phenomenal value, outperforming in-class laser devices for speed.[1,19] You can count on professional-quality colour documents produced with Original HP PageWide cartridges to be water-, smear-, and fade-resistant, for archival durability.[6] These devices deliver all-around savings with less maintenance and fewer replaceable parts than most lasers,[7] and lower energy consumption[4,5] than in-class laser printers.

HP PageWide Technology breakthroughs enable the high performance and robust print quality of HP PageWide printers. Exceptional features include a PageWide printhead with a nozzle density of 1,200 per inch for each of four colours, controlled ink-to-paper interactions using HP pigment inks, precision paper motion control, automatic nozzle performance measurement, active and passive nozzle substitution, and automated printhead service routines that can restore nozzle operation.

Learn more at
hp.com/go/pagewidebusiness

Notes

[1] Comparison of Enterprise devices based on manufacturers' published specifications of fastest available colour mode of colour business A4 MFPs $1,000 - $3,000 USD (compared to the 586 MFP series) and colour business A4 printers $500 - $1,249 USD (compared to the 556 printer series) as of November 2015, excluding other HP PageWide products, and products with 1% or lower market share using market share as reported by IDC as of Q3 2015. HP PageWide speeds based on General Office mode and exclude first page. Learn more at hp.com/go/printerspeeds.
[2] Single-pass, two-sided scanning is supported on the HP PageWide MFP 377dw, the HP PageWide Pro MFP 477dw and 577dw models and the HP PageWide Enterprise Color MFP 586 series only. Requires an Internet connection to the printer. Services may require registration. App availability varies by country, language, and agreements. For details, see hpconnected.com.
[3] Measured using ISO/IEC 24734, excludes first set of test documents. For details, see hp.com/go/printerclaims. Exact speed varies depending on the system configuration, software application, driver, and document complexity.
[4] Energy claim for Enterprise devices based on TEC data reported on energystar.gov. Data normalised to determine energy efficiency of majority of in-class colour laser MFPs $1,000–$3,000 USD and colour laser printers $500 – $1,249 USD as of November 2015; market share as reported by IDC as of Q3 2015. Actual results may vary. Learn more at hp.com/go/pagewideclaims.
[5] Energy claim based on TEC data reported on energystar.gov. Data normalised to determine energy efficiency of majority of in-class colour laser MFPs <$1,000 USD and colour laser printers <$800 USD as of November 2015; market share as reported by IDC as of Q3 2015. Actual results may vary. Learn more at hp.com/go/pagewideclaims.
[6] Water, smear, fade, and highlighter resistance based on ISO 11798 and internal HP testing. For details, see hp.com/go/printpermanence.
[7] Less scheduled maintenance based on 150,000 pages printed, and published comparisons of majority of in-class colour laser printers $300 - $600 USD and MFPs $400 - $800 USD (compared to the 352/377 series), $300 - $800 USD and MFPs $400 - $1,000 USD (compared to the Pro 452/552/477/577 series), and $1,000 - $3,000 USD (compared to the MFP 586 series and the 556 series) as of November 2015; market share as reported by IDC as of Q3 2015. Learn more at hp.com/go/pagewideclaims.
[8] Fax is supported on the HP PageWide Pro MFP 377, 477, and 577 series and the HP PageWide Enterprise MFP 586f/z models only.
[9] The term "die" comes from integrated circuit manufacturing and means a silicon chip. HP Thermal Inkjet printheads start out as silicon wafers with integrated electronics and heaters.
[10] With redundant power and ground connections, there are 16 physical conductors.
[11] LaserJet margins are 1/6 inch.
[12] Drop detection is typically done while the printer is idle, and the process can be interrupted by a print job.
[13] For example, a 600 x 600 dpi print mode.
[14] Based on internal HP testing of Original HP pigment inks on ColorLok® papers
[15] Comparison based on manufacturers' published specifications of first page out from ready and sleep mode of all colour business printers $300 - $800 USD and MFPs $400-$1,000 USD as of November 2015, excluding other HP PageWide products, and products with 1% or lower market share using market share as reported by IDC as of Q3 2015. Subject to device settings. Actual results may vary. Learn more at hp.com/go/printerspeeds.
[16] Measured using ISO/IEC 17629. Exact speed for first page out varies depending on the system configuration, software application, driver, and document complexity. Learn more at hp.com/go/printerclaims.
[17] TEC is based on ENERGY STAR measurement protocols. For more information, visit energystar.gov.
[18] HP Auto-Off technology capabilities subject to device and settings.
[19] Comparison based on manufacturers' published specifications of fastest available colour mode of all colour business printers $300 - $600 USD (compared to the 352/377 series) and all colour business printers $300 - $800 USD (compared to the Pro 452/552/477/577 series) and MFPs $400 - $1,000 USD as of November 2015, excluding other HP PageWide products, and products with 1% or lower market share using market share as reported by IDC as of Q3 2015. HP PageWide speeds based on General Office mode and exclude first page. Learn more at hp.com/go/printerspeeds.

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