HP Large Format PageWide Array Printer servicing Hardware

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Abstract

Unlike traditional Large Format Printers, with a scanning printing carriage that stops in a Service Station for Printhead Servicing, the new HP Large Format PageWide Array Printer has numerous Mechanisms that move to the Printheads to perform Maintenance tasks: These are the Fast Spittoon, Service Carriage, Blow Primer and Capping Station.

The Spittoon permits simultaneous spitting of all Nozzles inside a reservoir that has the capability to extract waste ink into an offline container. This reservoir, the spit during massive spit operations a lot of aerosol is generated inside the spittoon but it is also controlled and collected to prevent it from travelling into sensitive printer elements.

The printer has a Servicing Carriage that moves along the Printbar axis , where the Printheads are placed, that features a User Consumable Cloth Cleaning mechanism (aka Wiper) capable of performing 500 wipe full span operations before replacement.

It also houses a Drop Detector to measure nozzle health along the Printbar that closes the loop and permits a customized servicing strategy.

Finally, it has an Optical Sensor focusing the Printzone with which Alignment and color consistency calibrations are performed. This sensor allows us to calibrate media advance parameters and others like side edges, top and bottom of form.

In the event of severe issues like air ingestion, pigment settling or clogging a Blow Primer that is built in the each of the Printheads latching mecahnism can flush large amounts of ink out the nozzles at a pressure as high as that provided by the Ink Delivery System. Each Printhead is primed individually.

Last of all, the printer has a Printhead storage device called Capping System that provides maintenance of the moisture levels in the nozzles to ensure readiness to print and long term Nozzle health and protection.

Introduction

The new HP Inkjet Large Format Page Wide Technology Printers is a family of high-productivity color printers for technical graphics and reproduction services. An array of stackable inkjet print heads, also known as print bar, covers the entire paper width. The technology is easily scalable in size, productivity and image quality with a different number of modules per print bar or number of print bars. Improved stackability is obtained by the "S-shape" design of the modules. This shape allows them to fit together in a compact, linear print bar.

Compared to previous large format HP DesignJet printers, there is no need to move print heads while printing. Paper is moved below the print bar, which remains static. This results in a much higher productivity.

The first products using HP Large Format Page Wide Technology are HP PageWide XL 8000, 5000 and 4000 Printer series. They consists of a single 40-inch wide print bar, built with 8 print head modules. It is a 4-color pigment ink system that can print up to 30 D/A1 pages per minute.

200,000+ Nozzles require health maintenance during printing and in idle times. Being impossible to move the whole Printbar to a Service Station, as it is typically done on Scanning Printers, all servicing processes need to be made in place.

Printhead Cleaning, Nozzle Health detection, ink Spitting for refreshment and Printhead storage Capping are performed by several independent mechanical modules: The Service Carriage, the Fast Spittoon and the Capping Station.

The printbar, with the Printheads array, can move up and down to print and have the nozzles serviced with a vertical stop accuracy of 10 microns. *(figure1)*

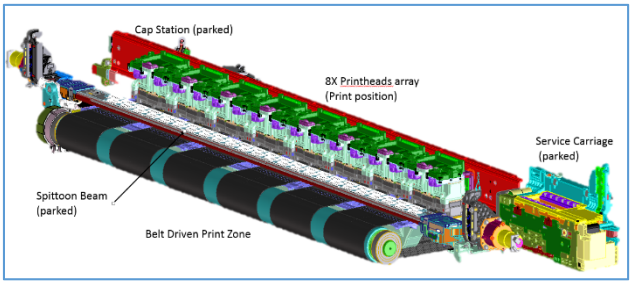

Figure 1

Service Carriage

The Service Carriage *(figure 2)* moves underneath the Printbar and above the PrintZone plate. While printing, it is garaged on the Printbar side. The carriage is impelled by a pulley-belt transmission driven by a DC motor. Speed Control is achieved by a motor axis encoder that provides an overall resolution of 4700 e.c/linear inch whilst positional accuracy of 1/600th inch is achieved with a linear encoder strip along carriage trajectory.

The service Carriage cleans the Printheads and carries the Drop Detector Module, which detects non-operating nozzles and provides inputs to Error Hiding algorithms.

It also supports an optical sensor that, focused downwards towards the Print Zone and Media, measures color consistency along the Printbar (die per die) and reads calibration plots. Output is used for PrintHead-to-PrintHead positional calibration and

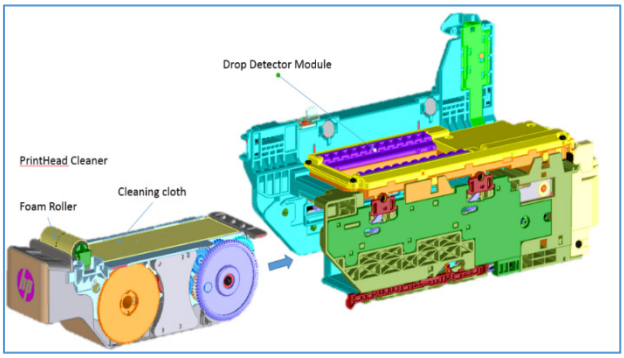

Figure 2

media advance Calibration.

Because the Parallelism requirement for Wiping is 2mm +/- 0.4mm along the PrintBar and the Focal distance one (Carriage to PrintZone) is +/- 0.3mm due to sensor response sensibility to height with respect to paper, Wiping interference and Printzone angles and offset are adjusted in manufacturing line.

Wiper- Printhead Cleaner

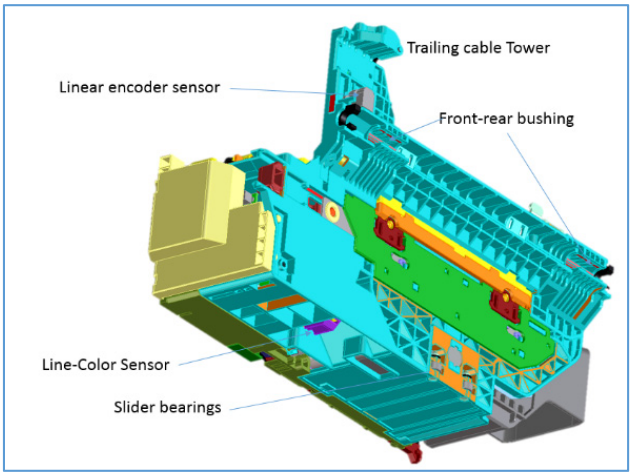

Figure 3

The Service carriage holds a User Replaceable Cartridge that can perform 500+ wiping operations. It is called the Printhead Cleaner. *(figure 2)*

To wipe the Printhead, the cleaning Cloth (aka Web Wipe material) is pressed against the bottom Shroud and Dice by a closed cell foam roller that ensures Normal wiping force and proper accommodation to edges and bumps in the PrintHead bottom surfaces, where ink gunk, aerosol and fibers accumulate during printing. Wiping is done bi-directionally. Prior to every wipe operation, the cloth roll is advanced to present clean material on the roller top nip by a motor on the carriage.

Drop Detector

To enable high speed nozzle health measurement of the whole PrintBar, a compact solution of 12 optical drop detectors working in parallel has been designed. Each individual Drop Detector Sensor consists of an emitter LED and a receiver Photodiode. A train of drops is fired across the light beam and the response perturbation is sensed to declare whether or not a nozzle is properly firing

The Drop Detector *(figure 4)* is driven at a constant speed of 1,1 inch/sec below the print bar. As the drop detector advances, each of the 12 optical sensors measures an individual nozzle. Nozzle firing Trigger is provided by the linear encoder sensor mounted on the carriage. After scanning the full span of the print bar, half of the nozzles are measured. A second pass is needed to complete the measure of all nozzles of the print bar.

The Carriage lifts the Module when a Drop Detection is to be done to minimize distance and fly time of drops from Nozzle to DD light beam. This design allows a fly distance of 3.8 to

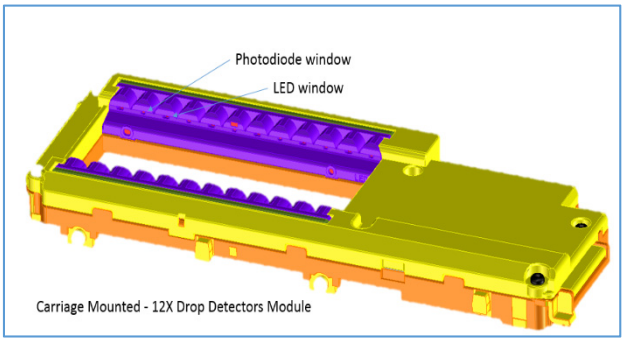

Figure 4

4.5mm (full range of variability across the Printbar)

The design is easily scalable to other product sizes and productivity requirements. Products with more print bars can just replicate the servicing carriage and drop detector for each print bar. Smaller or bigger products can also vary the number of sensors relatively to adapt to the size and productivity requirements. The sensor can also be used in inkjet scanning products. The distance between 2 consecutive sensors is only 9,4 mm, which allows for a very compact design.

Line and Color Calibration Sensor

The Sensor is a 4-LED (Blue, Red, Ambar, Green) densitometer that is used to calibrate color consistency between Printheads by providing the capability to adjust firing parameters individually to each die and, therefore, change resulting color.

It is also used to read alignment patterns that are printed to be able to calibrate the Printhead to Printhead distance in X (dice direction) and Y (media advance direction).

Every time a new roll is loaded the Carriage sensor reads side edges position to validate media width and fix printing margins position.

The sensor is very sensitive to focal distance in terms of response to color readings so the tolerance is very tight. It must be at 11mm -0/+0.6mm. This is achieved in the manufacturing line by adjusting Printzone angles, height and planarity. *(figure5)*

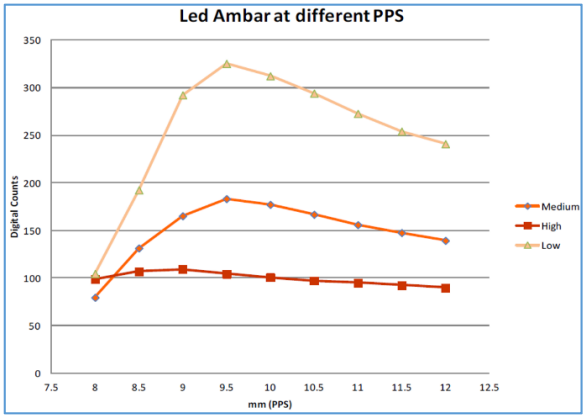

Figure 5

Fast Spittoon

In order to keep Nozzles fresh, ready to print, it is necessary to spit ink through them every 2-3 seconds at least. During printing this is not a problem but in idle times waiting for a print job or during a media roll change within a job, this becomes challenging.

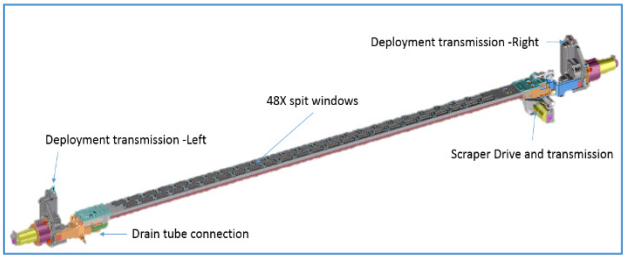

Figure 6

In this Printer we have implemented a beam-like Spittoon that can be deployed very fast to a position underneath the Printhbar and have the Printheads spit in its windows. To do so, the Printbar lifts to a determined height and the spittoon is guided, in media advance direction, to the spit position. The time it takes to go from spit position of the Prinbar to the Print position is less

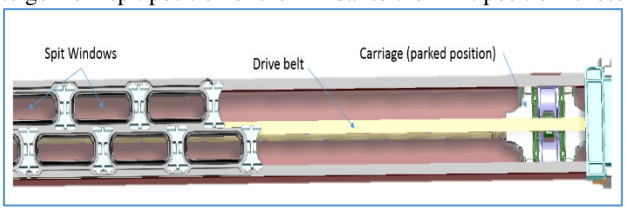

Figure 7

than 2 seconds, allowing to start printing with fresh and ready nozzles.

The spittoon *(figure 6)* collects large amounts of ink that cannot obviously accumulate in the sleek spittoon beam. Inside the beam there's a carriage with side and bottom scrappers that is belt driven by a motor, when parked and engaged to the transmission. It wipes all the spittoon beam length and pushes spitted ink towards drain on one end of the beam that leads to a waste ink container, which is also a user replaceable consumable with a 2 liter capacity.

When 200,000+ nozzles spit simultaneously, large amounts of aerosol are generated. To control it, Spit windows feature individual rubber seals that contact the surrounding of the dice *(figure 7)*. Also, through the drain tube, a suction fan generates an air stream that carries aerosol towards the drain and collection system.

The Spittoon is also used to install new Printheads in the printer, which is also user replaceable. New Printheads come loaded with a shipping fluid, a sort of ink vehicle that does not get degraded during storage or transportation, unlike ink. Every printhead loads around 100cc of shipping fluid and this needs to spit out and replaced by ink. It is in the Spittoon system where this is collected and driven to the waste container.

Capping Station

The capping station *(figure 8)* is a set of 8 individual cap rubber seals, one per printhead, that ensure proper conditions maintenance of Nozzles in printer idle times. The printbar will go to Cap Position after barely 20 seconds without receiving a command to print.

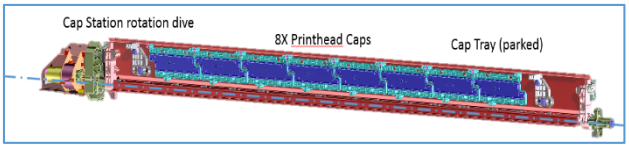

Figure 8

Each individual Cap Seal *(figure 9)* presses against the printhead with a force of 12 N to ensure sealing and moisture maintenance in the Nozzle areas. This function is critical to avoid evaporation of Ink vehicle and color change, pigment crusting or precipitation.

The Capping seals are all mounted on a rotating Tray that moves underneath the printbar. It is the prinbar vertical motion that creates the compression of the cap seals springs to a pre-determined position.

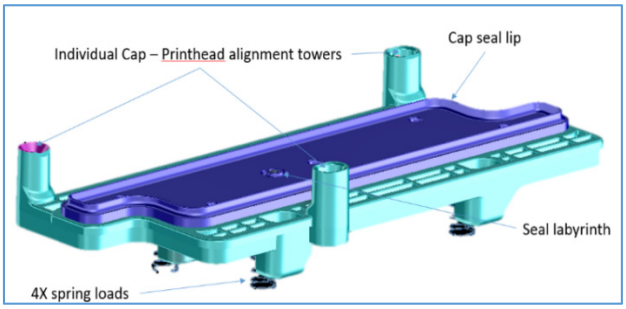

Figure 9

Nozzle Health Strategy

All Servicing processes are triggered automatically by the printer depending on printing volume (Pages, ink amount or time) and so are Drop Detections, which close the loop and permit the optimization of the servicing strategy. The Drop detector provides reliable information on what the nozzle status is and Error Hiding and Servicing algorithms are adapted

Expectations for printing CAD is maximum productivity, therefore drop detection, wiping and spitting are triggered less frequently than when printing renders or posters. For the latest, customers prefer slower more robust printing on higher quality and more expensive paper. On those cases, drop detection is done more frequently and Wiping and Spitting are thoroughly done to ensure optimal print quality.

Printhead Cleaning can also be manually triggered from the Printer front panel if required by the user at the beginning of a long job or if printing defects are detected.

The Servicing systems described above provide flexible and adaptable servicing to PWA Printheads. In the future, with inks o that may have different needs, wiping interference, speed or even wipe material is easily configurable and spit patterns can be adapted to new conditions.

Acknowledgements

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Biography

Rafael Ulacia Portoles received his M.S in Mechanical Engineering from Escola Tècnica Superior d'Enginyers Industrials de Barcelona (UPC) in 2001. He joined Hewlett-Packard in 2002 and since then has worked in the development of a wide variety of mechanical systems for Large Format printers, mostly focused in the field of Printhead Health Systems and Ink delivery.