HP Pagewide System Printhead Architecture for a Compact Printer

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Abstract

When designing a pagewide thermal ink jet printing system you can use one of three different engine architectures. The first is "design for width" where individual silicon die are assembled into a monolithic printbar which is wide enough to print on the media size you are targeting. HP's OfficeJet Pro x uses this approach, and it provides the smallest and least expensive path, but it gives you no direct flexibility in print width.

The second architecture stacks monolithic printbars into a wide array like you would stack bricks to make a wall. While this provides media width flexibility, it creates a much wider print zone where you must keep the media flat, and a bigger zone where you must maintain absolute position and velocity control. Even then there will be artifacts created between the staggered printbars caused by differential drying time. And of course the printer itself becomes larger. But this system can allow you to bring large products to market quickly, and HP has done this with its family of ink jet based web presses.

The third method involves designing a nestable module, several of which can then be assembled into printbars of various lengths, from an office printer size machine up to the 40 inch print swath recently introduced on the HP pagewide product. This approach combines the low cost of architecture 1 with the flexibility of architecture 2. And since each module is individually replaceable it is more convenient for the customer as well. This paper focusses on some of the benefits and challenges of the nestable design.

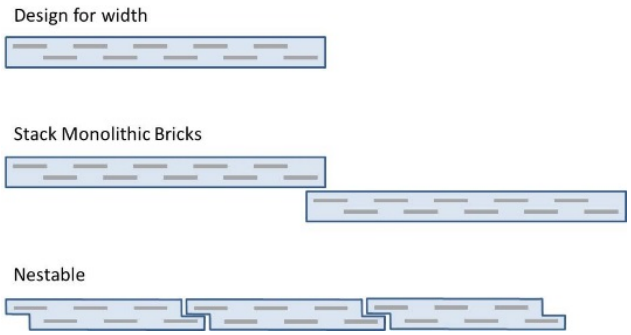
Introduction

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 achieved by the nestable "S-shape" design of the Printheads. 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.

The requirements in terms of printhead positioning among them are very high and so is the need to create a compact layout. To achieve these 2 objectives both in Media advance (Y direction) and Nozzle axis (X direction), a side-datuming structure has been designed and implemented in Large Format HP Pagewide Printers. As it will be explained, this referencing structure also allows to have all Printer-to-Printhead interfaces aligned in Z direction and mostly contained in the Latching system. The Electrical power and data interfaces and a Printhead priming airport are contained in the latch whilst the 4-ink fluidic interface



Printhead to Printer datuming

8 Printheads are nested in line, supported and referenced to a beam-like structure called PrintBar (*Figure 1*). The Printbar moves up and down to allow servicing of the printheads but it is it's bottom-most position where 2 hard stops provide consistent Printhead-to-Paper spacing (PPS) across the 40" PrintZone. These hardstops are adjusted in the manufacturing line to ensure a PPS of 1.35mm +/-0.3.

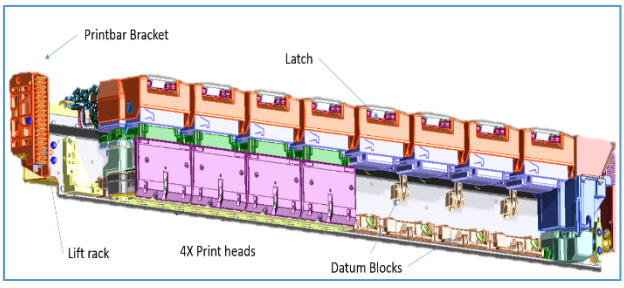


Figure 1

A reliable and repeatable Datuming system *(figure 2)* is necessary for the proper registration and alignment of Printhead modules among them and with respect to printbar datums. Position tolerance, Printhead to Printhead, in the 3 axis is +/- 50 microns and the latching system provides a top preload that ensures re-seating of the Print-head on the datums.

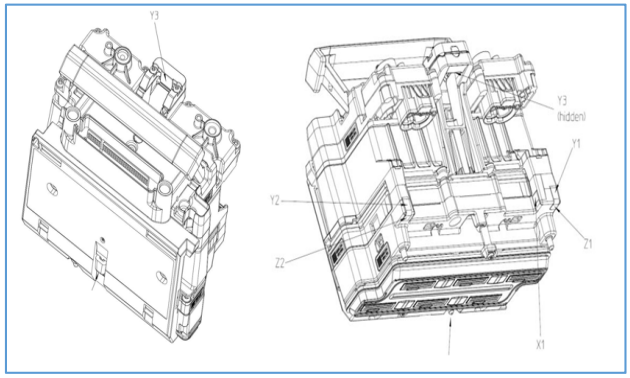


Figure 2

A cantilevered mounting of the print-head design permits a very compact configuration in media advance direction, 200 mm including all Printbar servicing modules

The Datum Reference Frame for mounting and registration of the print-head in the Printbar uses Y1, Y2, Y3, Z1, Z2 and X1 datum features with the following order of precedence:

Y-primary (vertical plane, composed of datum features Y1, Y2, and Y3);

Z-secondary (horizontal line, composed of datum features Z1 and Z2);

X-tertiary (point, datum feature X1).

On the Printbar, a set of 8 Bottom Datum Blocks, contain the Y1, Y2, Z1, Z2 and X Datum planes and a set of Y3 datum Blocks mate the Printhead Datum surfaces.

For the system to work properly and ensure resistance to shock and vibration, pre-load in X direction is applied aligned to the X datum pad. Same happens in Z direction: A mechanism called the Latch produces a 4-point preload in Z direction.

Latching System

The latch mechanism *(figure 3)* has a rotating head that clears the way for the Printhead to be installed and replaced. It has a lever mechanism that amplifies latch actuation by the end user to produce an amplified pre-load on the Printhead.

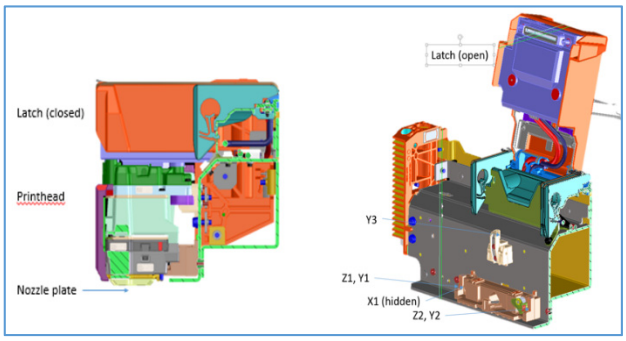


Figure 3

When in closed position it provides an overall latching force of 120 Newton applied in 4 points. Force distribution has been defined to ensure proper reseating in case there's a separation of the printhead out of any of the datum pads.

The latch is self-centering with the Printhead to ensure adequate alignment of the PCI- Express board, the electrical interface to the Printhead. A pump capable of blowing air through the Priming port is contained in the latch too.

Ink Delivery System

Of course, The Printbar supports a 4-ink delivery system to the Printheads. It consists of a set of 8 connectable manifolds *(figure 4)*, mechanically linked and fluidically connected, that distribute ink to the Fluid Interconnect Towers. These towers feature a rubber septum in which the 4 Printhead needles get inserted.

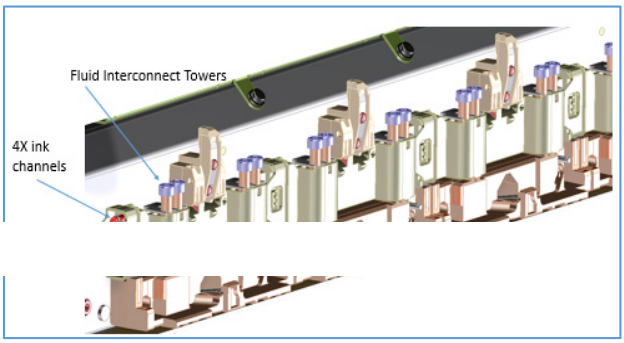


Figure 4

Once the 8 modules are assembled they behave like a beam and can be installed and repaired as a unit

Printbar Structure and Manufacting

The Printbar beam consists mainly of a closed profile beam made of 2 bent sheet metal plates. On both ends, brackets that features the racks to gear with the lifting pinions. These Brackets also support the PPS, Pen to Paper Spacing, Screws that ensure controlled gap between Nozzle plates and media.

The Sheet metal plates have attached the 8 sets of datum blocks and latches hinges. As it can be imagined, the tolerance stack and the inherent dimensional variability of the system parts,

molded plastic and Sheet metal parts, would make it impossible to achieve adequate positional tolerances Printhead to Printhead and Printhead to media positional tolerances.

To solve this, each Printbar gets all Datum Blocks pads, made of reinforced plastic, machined in one single milling operation (6X8 Printhead datum surfaces plus other reference surfaces). The milling station replicates Printbar operational structure: Rods, actual Systems and Printheads mass pre-load and Z-stops. In this operation any Datum pad tolerance with respect to any other milled featured is reduced to less than 50 microns.

CONCLUSIONS

A nested layout of Printheads permits a very compact layout and provides a very convenient user interface for user replaceable Printheads.

The design effort made to develop the Printheads and the Printer Printbar has been enormous but it has resulted in a highly integrated Printbar module that is not only scalable in length but also in the number of Printbars that can be added to a Printbar. With a potential Printbar to Printbar pitch of 205mm, multibar Page Wide Array printers can be easily imagined.

In terms of PPS (Printhead to Paper Spacing), the overall tolerance stack includes contributions from the Printzone and all elements that link it to the Printbar supports, the printer sideplates. To achieve a PPS of 1.35 +/- 0.3, each subsystem has been optimized for precission. The Printbar and Printheads is where this effort has been bigger.

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.