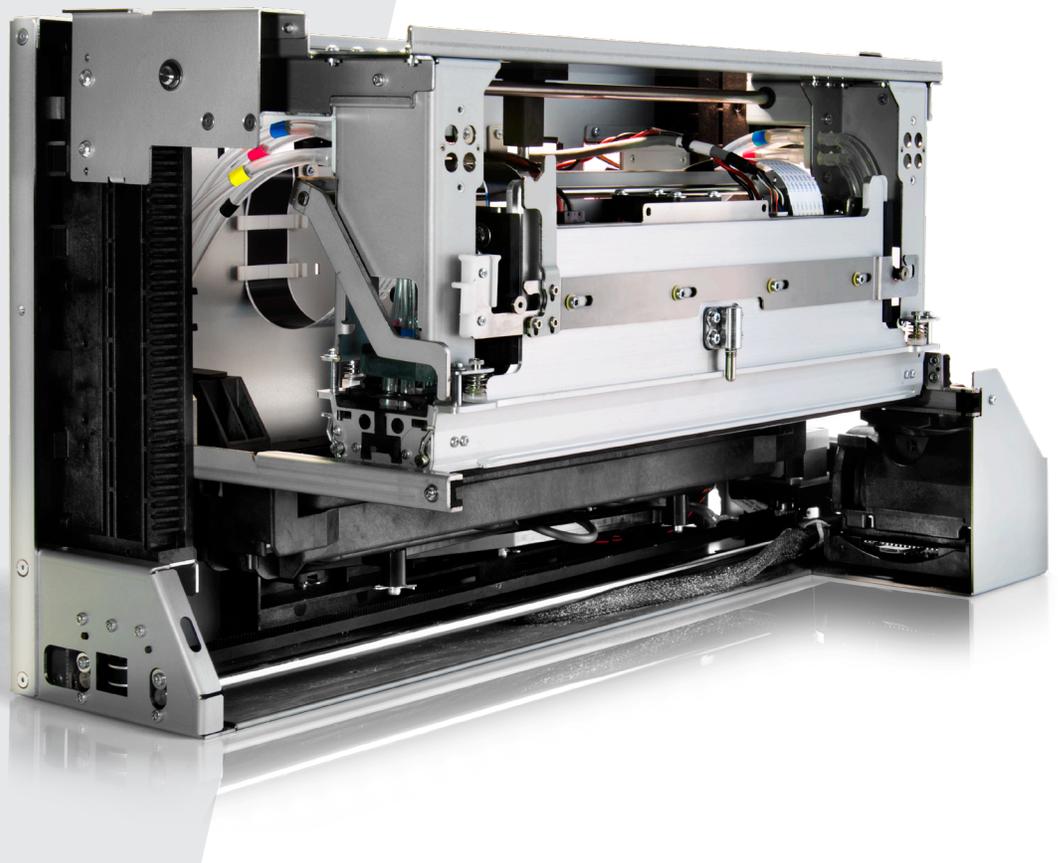


A DuraFlex® Technology White Paper



memjet®

Beautiful Precision, Simplicity, and Affordability.

We Are R&D

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Part 1

DuraFlex® – Incredible Integration

Introducing DuraFlex, the affordable, flexible, highly-integrated, four-color platform from Memjet®. This new digital platform is a game changer, enabling Memjet OEM partners to capture new opportunities and open up new markets.

DuraFlex is Memjet’s economical and flexible technology that introduces a completely new four-color printhead in A4 and A3+ widths. Using the proven printhead ICs from Memjet’s DuraLink technology, DuraFlex provides long-life printheads with durable pigment inks in a highly integrated, ready-to-print module—enabling fast and cost-efficient development of print solutions for a range of applications and markets.

Industry-Leading Speed and Quality

Together, these features provide industry-leading quality and speed for a range of applications. This robust technology enables fast and cost-efficient product development, industry-leading native resolution, and small drop sizes for high print quality up to *1,600 × 1,600 dpi, with 2× nozzle redundancy, and print speeds of 46 m/min (30 in/sec, 150 ft/min).*

Inches per Second	Feet per Minute	Meters per Minute	Resolution
18 ips	90 ft/min	27.4 m/min	1600 x 1600
30 ips	150 ft/min	45.7 m/min	1600 x 954

Figure 1 – DuraFlex Maximum Speeds, by Resolution Control

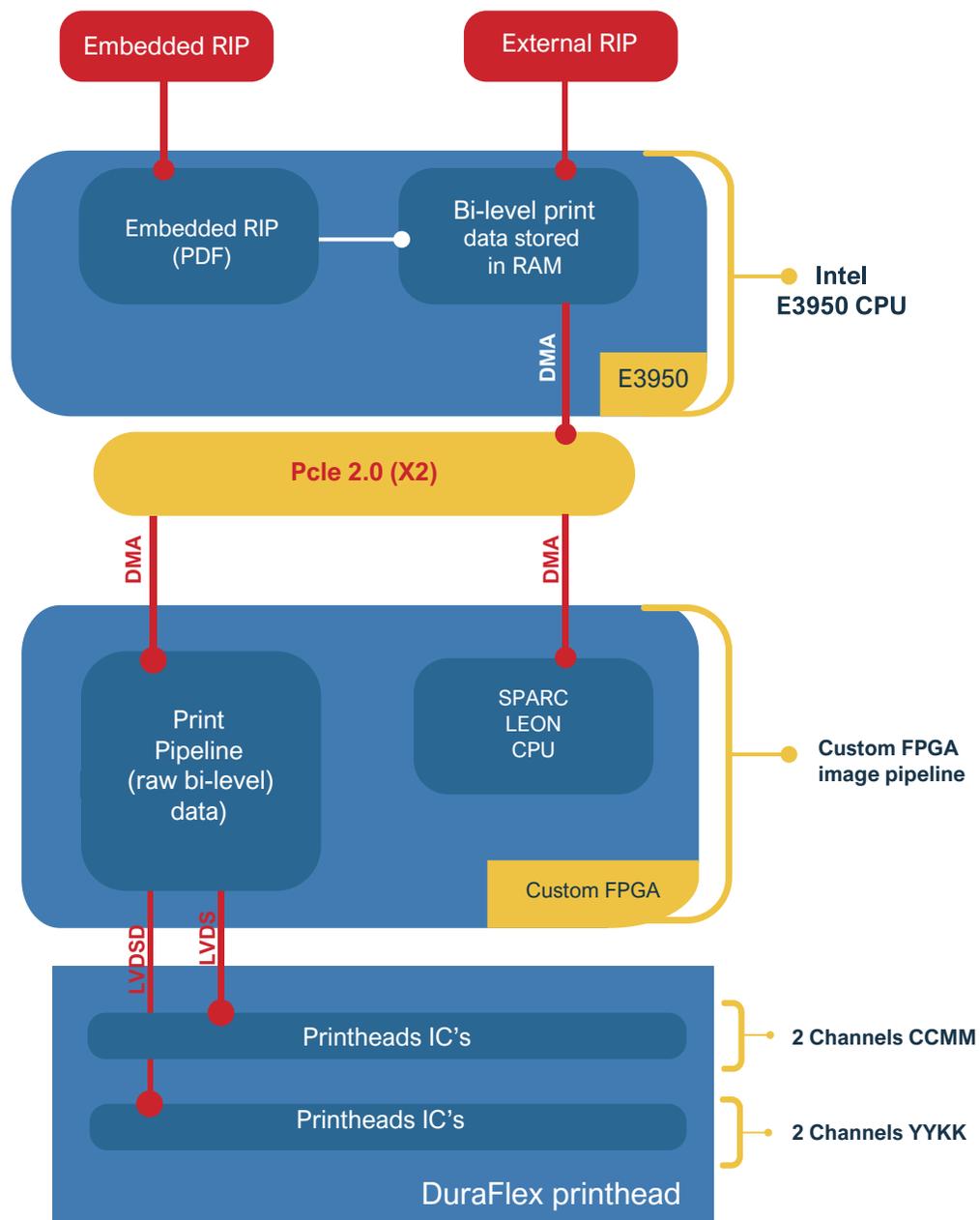
Memjet DuraFlex Technology

Building on the success of Memjet’s original VersaPass and DuraLink technology platforms, Memjet now introduces DuraFlex; a single-pass, digital printing platform that features a four color, long-life printhead with durable pigment inks. Printheads come in both A4 and A3+ variants, allowing print widths of 222 mm (A4) and 324 mm (A3+). Multiple A3+ modules can be stitched together for wide format applications up to 1.25 meter (50 in) maximum print width (4 × A3+ wide prinheads). The DuraFlex system includes printheads and inks in a fully-integrated printhead support module. The modules provide ink delivery and management, printhead maintenance, custom support electronics with control and interface software. Memjet has done all of the hard work to provide a turn-key offering with all the support software and systems provided with a well-defined interface. OEMs add the media handling system and any custom software (drivers, RIPs, etc.) as needed for the specific application.

Print Data Pipeline with Custom Controller Chip

The DuraFlex print data pipeline provides for both uncompressed, dot-level control of print data streams from an external RIP, or a fast, embedded RIP for processing PDF images.

Figure 2 - DuraFlex Data Pipeline with Dot-Level Control



Part 2

The DuraFlex[®] Printhead

The central component of DuraFlex printing is the 163,840 nozzle (A3+) and 112,640 nozzle (A4) inkjet printhead.



Figure 3 - The Memjet DuraFlex Printhead

Incredible Integration Industry

The all-new DuraFlex printhead provides for an extremely compact, integrated and complete 4 color implementation with built in nozzle redundancy. Featuring two rows of the well-proven Memjet Printhead IC, it provides for true 1,600 dpi resolution in both an A4 (222 mm) and A3+ (324 mm) wide variant. Eight nozzles (two per color) address every dot position on the printed page for a 2x nozzle redundancy, providing for increased levels of image robustness and tolerance of non-firing nozzles.

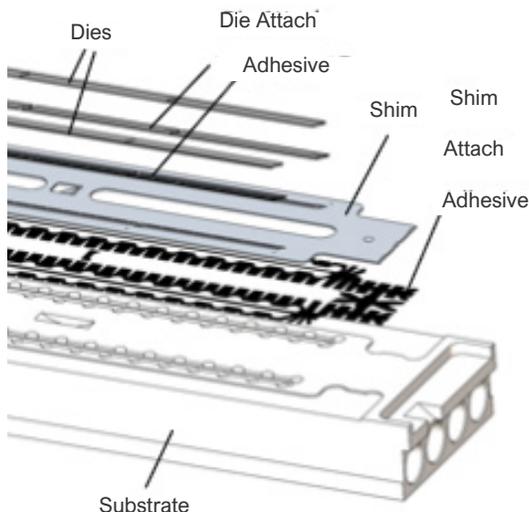


Figure 4 – Construction details of Memjet DuraFlex Printhead

To cater to this level of integration – and increase in printhead width – an entirely new design has been created. Ink channels allow for flow-through circulation to ensure ink can be refreshed and air ejected. Wide fluidic channels deliver ink to the ICs and can supply an astonishing peak 84 mL/min of ink flow to ensure 100% operation of all nozzles.

Excellent print quality is sustainable for well over 1 billion ejections per nozzle for each CMYK color. While operational lifetimes vary depending on printed content, end users will see a maximum life of 80 L for an A4 printhead and 120 L for an A3+ printhead. Figure 4 shows magnified images of lines that are 1 dot wide, with rectangles 254 μm (1/100" or 16 dot pitches) wide, comparing a print at the start of life of a printhead (top) to a print after 1 billion ejections (bottom). Even after a billion ejections, the print quality is exceptional.

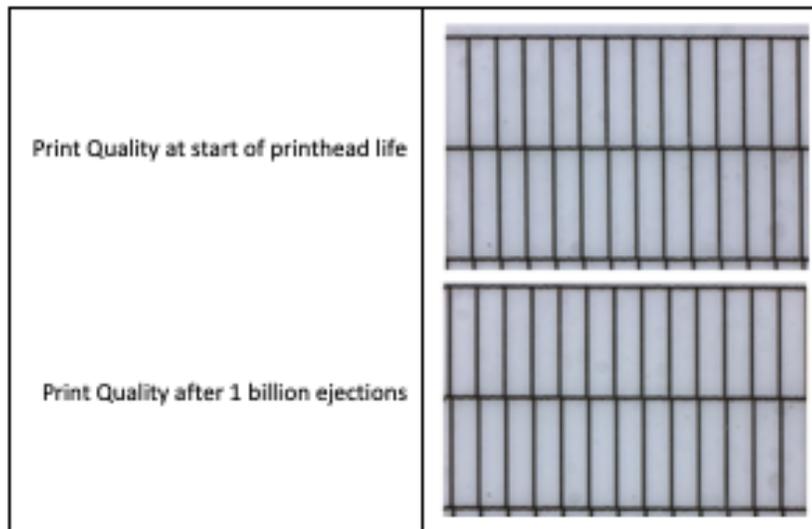


Figure 5 - Print Quality Testing Comparison (Magnified)

Designed for Quality and Durability

The new DuraFlex Printer IC design features a coated, bonded heater element. The coating provides durability while still allowing efficient ejection energy transfer, while the bonding of the heater with the chip substrate provides another layer of robustness. Along with specifically designed aqueous pigment inks, the new design contributes to longer life, ejection stability, and excellent print quality.

DuraFlex produces 2.1 pL drops up to the recommended maximum nozzle firing frequency of 15.5 kHz – providing an effective frequency of ejection at the printhead level of 31 kHz per color. It has improved bubble tolerance and priming robustness via its “open” fluidic architecture. A new MEMS structure within the Printer IC improves the consistency of chamber depth and hence the droplet size, and the patented symmetric chamber design improves drop trajectory consistency thereby reducing drop misplacement.

Part 3

The DuraFlex[®] Pigment Inks

DuraFlex aqueous pigment inks deliver market-leading print quality and outstanding durability while enhancing printhead reliability and extending the life of the printhead.

Years of Research and Development

In co-development over five years, Memjet and a leading pigment dispersion manufacturer have developed DuraFlex aqueous pigment inks for excellent ink-on-media performance with DuraFlex printheads.

The challenges we set for these inks were steep: it needed to achieve waterfastness, be resistant to light fade, be compatible with a broad range of media, provide competitive gamut image quality, high reliability, and long printhead life - all within the low-cost, quick dry time, small drop-volume Memjet thermal inkjet printhead.

Custom polymers, designed for broad media compatibility, are combined with base colors to produce the pigment dispersion. The particle size is controlled during dispersion to optimize color properties, fade resistance, and facilitate good jet-ability from the printhead. Advanced purification processes are used to support Memjet's small drop size and fluidic structure. The pigment dispersion is combined with a specialized ink vehicle (containing co-solvent and surfactant packages, additives, and special binders), and water, to optimize print quality, speed, abrasion resistance on glossy media, and printhead life.

High Print Quality with Image Durability and Printhead Reliability

DuraFlex aqueous pigment inks support excellent image quality on a range of media, while ensuring resistance to damage from rubbing, moisture, and light.

DuraFlex inks provide competitive gamut and image quality on a range of uncoated papers as well as inkjet treated and inkjet coated media for benchtop, light production printing and cost-sensitive wide-format applications. DuraFlex inks, when used with appropriate media, are compliant with BS5609 marine labels applications. DuraFlex inks have been developed for use in indirect food contact applications.

- | Each ink component is reviewed for its impact on food safety
- | Each ink complies with the EU Framework (EC) No 1935/2004
- | Each ink complies with US CONEG Model Toxics in Packaging Legislation and contains no: mercury, lead, cadmium or hexavalent chromium
- | Every ink component is listed on the Swiss Ordinance, or has been approved for listing

Waterfastness and Fade Resistance

Waterfastness and fade resistance are the biggest reasons for choosing pigment inks. DuraFlex inks meet those requirements and are waterfast with excellent fade resistance.

Memjet conducted tests with DuraFlex inks to evaluate indoor light fade. Using the Wilhelm Imaging Research (WIR) method of accelerated testing, colors are still vibrant after 40 years, compared to an unexposed, original print, as illustrated in Figure 6. Accelerated testing for ozone fade showed 25+ years.

Media Compatibility

DuraFlex pigment inks are compatible with media commonly used in inkjet applications, including:

- | **Plain papers (bond, uncoated offset)**
- | **Inkjet treated uncoated papers**
- | **Inkjet coated media**

At the time of publication, Memjet has already tested over 40 medias from more than 10 manufacturers with DuraFlex pigment inks, and the compatibility testing continues. Compatibility with media is expected to extend to media used in a variety of packaging applications, as well as on some special media, such as coated films, vinyl, and label stock.

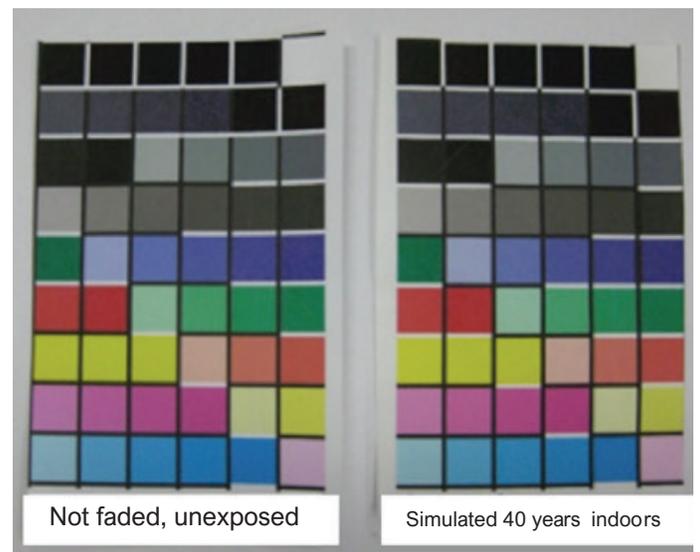


Figure 6 – Simulated 40-Year Indoor Light Fade Test: Just Printed (left) vs. Print Subjected to Fade Conditions (right)

Gamut

Memjet's DuraFlex pigment inks provide competitive gamut-among the widest in the market. This gamut is competitive with leading inkjet solutions, especially when printed on inkjet coated media. The graph in Figure 7 shows Memjet's gamut on three different media types.

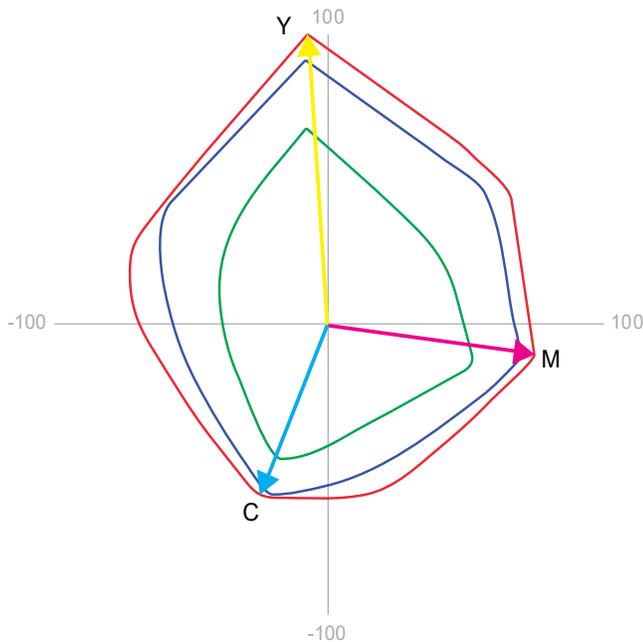


Figure 7 - DuraFlex Pigment Inks Gamut - by Media

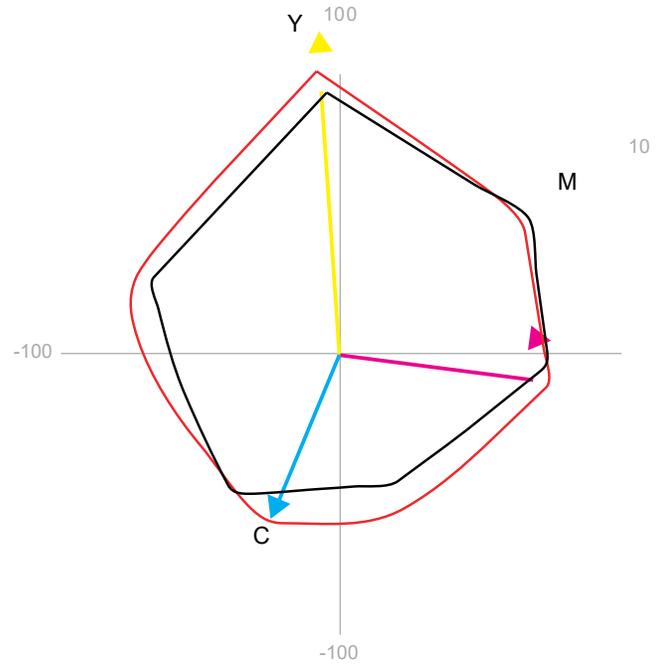


Figure 8 - DuraFlex Inks Gamut on Coated Media, Compared to GRACoL Coated Gamut

Key (from inner to outer on diagram):

- Plain
- Inkjet Coated Matte
- Inkjet Coated Gloss

General Requirements for Applications in Commercial Offset Lithography (GRACoL) has become a standard in pressrooms, labels and wide format industries in North America. GRACoL is not just a set of colors, but a set of methods on how to calibrate a printer to achieve consistent color. This repeatability leads to reduced costs in time and waste when reproducing work. DuraFlex inks on inkjet coated media compares favorably with GRACoL coated, as shown in Figure 7.

Key: (from inner to outer in diagram):

- GRACoL Coated Gamut
- DuraFlex Pigment Inks Gamut

With formulations comprised of over 70% water, and free of reactive chemistries, Memjet DuraFlex inks are safer to use and are friendlier to the environment than UV, solvent, or liquid toner inks. The formulations are free of hazardous UV ink components such as 4-methylbenzophenone or benzophenone, phthalate esters, bisphenol-A (BPA), mineral oil aromatic hydrocarbons (MOAH), and do not contain any SVHCs (Substances of Very High Concern per REACH) or toxic metals as regulated by RoHS.

Part 4

The DuraFlex® Module Set

The Print Module

The DuraFlex Print Module brings everything together in one fully integrated, ready to print package. Just bolt onto your media path, connect the power, data and ink for a system that can be printing in no time. These modules significantly reduce the development time and costs for OEM partners for fast integration and commercialization.

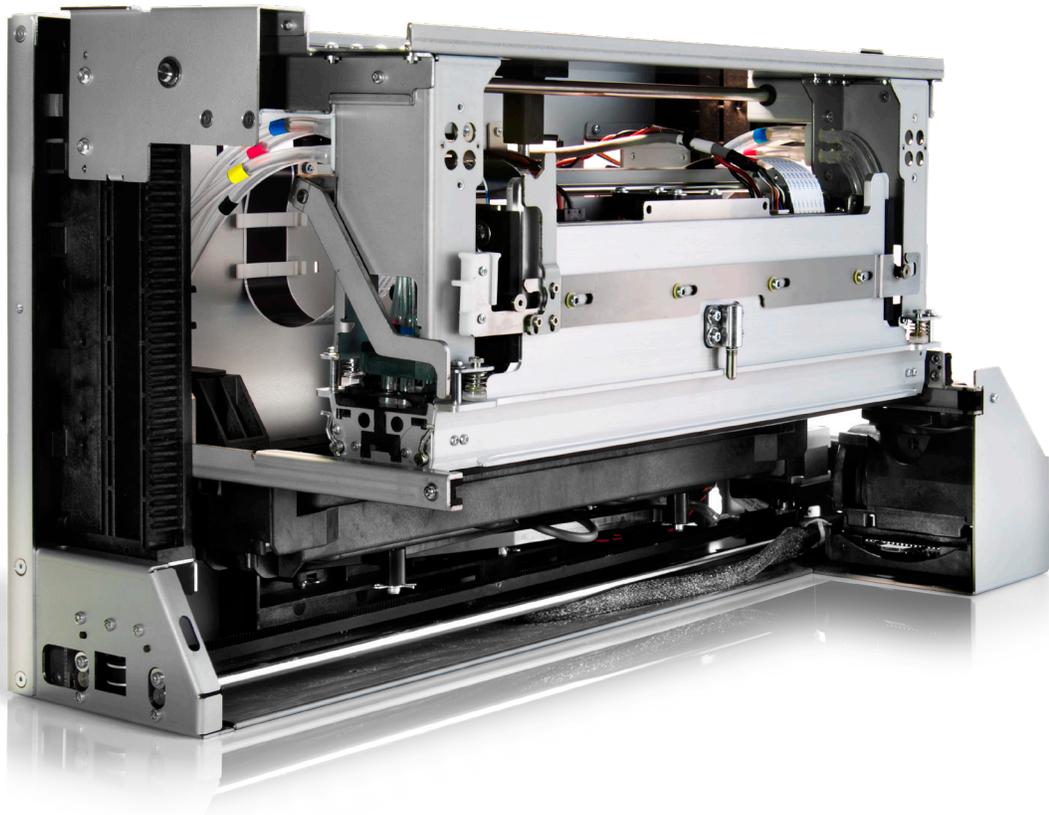


Figure 9 - DuraFlex Print Module

The Print Module houses the printhead, maintenance (wiper and cap) and electronics. It enables the printhead to be moved into position for printing, and enables the automated wiping, maintenance and capping of the printhead when not in use. Mounting points enable it to be accurately positioned over the printing media path of choice. The maintenance station is above the web, meaning it is compatible with both cut-sheet, roll-to-roll and belt-driven applications.

The Ink Delivery System Module

DuraFlex manages the delivery of ink via the integrated Ink Delivery System Module (IDS). The IDS draws ink from the bulk ink tanks and channels it to the Print Module for printing. It also provides for appropriate pressure and flow management, filtration, and the automated priming of the printhead for quality printing.



Figure 10 - DuraFlex Ink Delivery System - by Media

The Ink Management Module

The Ink Management Module provides a controlled vacuum to facilitate printhead priming and maintenance operations while collecting the small amount of ink drawn from the printhead cap and wiper during those operations. The waste ink is fed into an OEM-supplied container.

Aerosol Management Module

The Aerosol Management Module is optional. Using an OEM-supplied vacuum, the Aerosol Management Module is a nozzle and housing designed to be positioned close to the printhead for efficient extraction of aerosol from the print zone.

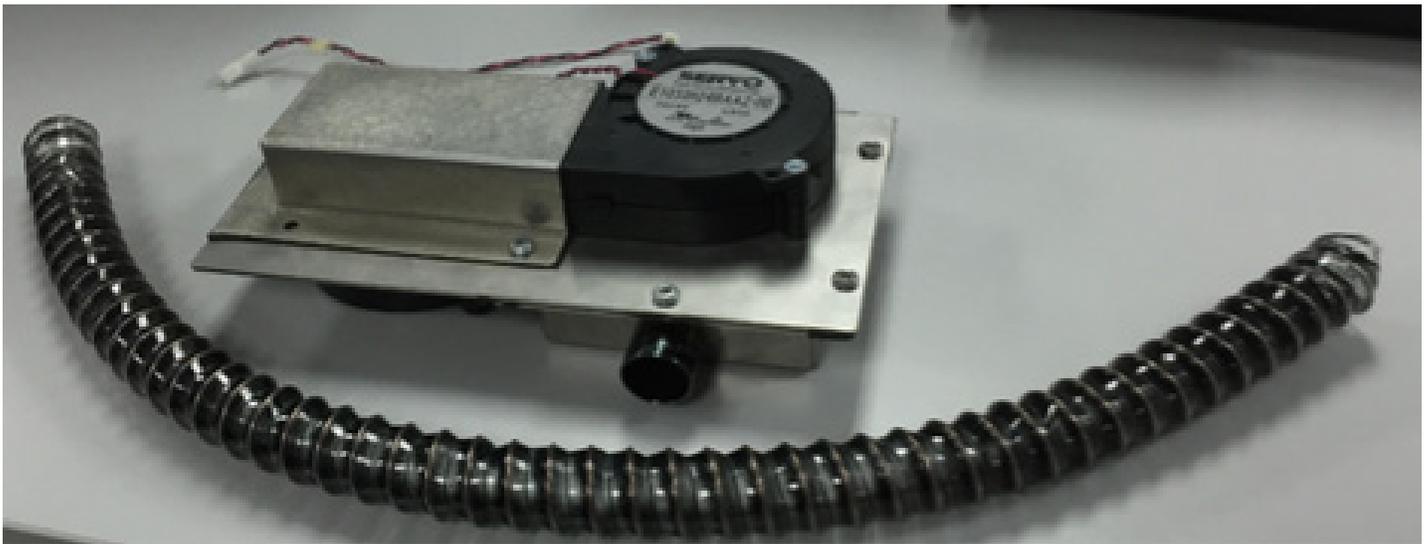


Figure 11 - DuraFlex Aerosol Management Module

Part 5

DuraFlex[®] Software

In addition to modules and components, Memjet provides supporting software to control the printing function. The DuraFlex software provides both datapath processing and automated control of the functionality to keep the printhead at optimal print quality. Well-defined interfaces are provided to minimize OEM integration time and to ensure rapid development of products.

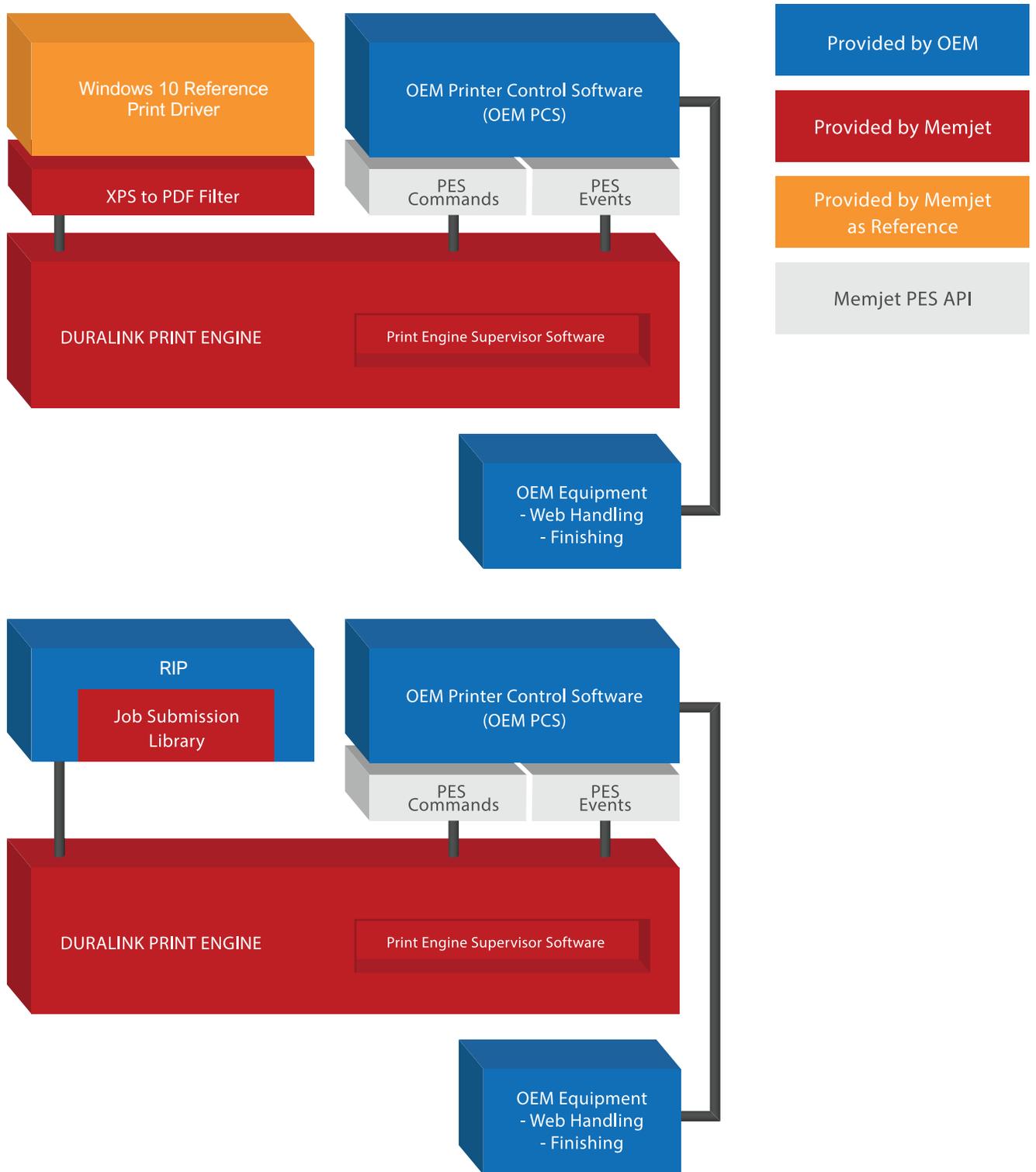


Figure 12 - Memjet Reference DuraFlex Printer and OEM System Architecture

Print Engine Supervisor (PES) is the software that coordinates functions of the DuraFlex Print Engine. This software provides the OEM with an interface that supports multiple programming languages and environments by utilizing the Apache Thrift RPC framework.

- | The Print Engine Supervisor (PES) Interface provides the OEM with a command set to control the DuraFlex Print Engine. In conjunction, an event interface is used to update the OEMs software with status, state changes and diagnostic information.

The DuraFlex Print Engine is equipped with a fast, embedded RIP that will process PDF files into dot-level data.

- | A Windows 10 Reference Printer Driver is provided to OEMs that will generate a print optimized PDF. A host utility is included, which is responsible for detecting and transmitting the generated PDF to the Print Engine's embedded RIP.

Alternatively, OEMs can choose to utilize an external RIP of their choice in place of the embedded RIP.

- | The Job Submission Library (JSL) is provided to OEMs which will enable integration of an external RIP with the DuraFlex Print Engine. This library is responsible for taking dot-level data generated from the RIP and transmitting the print data to the Print Engine in the accepted format. The Job Submission Library is provided as a Windows C Library DLL.

Part 6

Building the Future of Print

By enabling flexible printer development and providing outstanding speed, print quality, durability, and remarkably long-lasting printheads, DuraFlex gives OEM partners the resources they need to build powerful yet affordable printing solutions. Together, these features expand Memjet's industry-leading speed, simplicity, and affordability to a broader range of office, commercial, packaging, and industrial printing markets.

DuraFlex® from Memjet. Brand new platform. **All new potential.**

To learn more visit www.memjet.com/technology/duraflex
or email us at info@memjet.com.