

# D & A

DESIGN & AUTOMATION UPDATE

## PART 2: FLUID DISPENSING FOR **BETTER PROCESS CONTROL**

Manufacturers upgrade to the latest automated and semi-automated fluid dispensing systems.

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*Part 1 looked at current technology in fluid dispensing and process control. Part 2 looks at the range of dispensing options – in-line automated robotic fluid dispensing, contact dispensing vs. non-contact jetting, vision-guided robotic dispensing, and benchtop fluid dispensing for medical device assembly.*

### In-line automated robotic fluid dispensing

Automated robotic dispensing has evolved to support the needs for higher throughput in the assembly of medical devices, point-of-care diagnostics, and near-patient testing products by developing specialized dispensing technologies for automated in-line and near-line assembly.

Highly automated, in-line jet dis-

ensing technologies deliver precise microdots of fluid onto substrates within extremely short cycle times, at rates up to 1,000 cycles per second (CPS), and with infallible repeatability.

In most applications, a series of small micro-deposits are put down dot-to-dot that stitch together, blending seamlessly to make a continuous line or pattern. Any shape or solid can be created on a substrate by stitching dots with micro-dispensing. Multiple microdots can be stacked to form larger dots. Dispensed microdots are 300µm to 400µm in diameter. Within these parameters, real-world applications typically require many different sized dot diameters to accommodate the different sized components populating a substrate. Micro-dispensing technologies can deliver extremely tight deposit tolerances within 1% of project specification for size, height, and shape of the microdots.

### Contact dispensing vs. non-contact jetting

There are two basic types of fluid in-line micro-dispensing techniques: classic needle-based contact dispensing and non-contact jet dispensing. Although traditional contact fluid dispensing is still the predominant technology in use, it's hampered by definite disadvantages of speed, particularly when dispensing on irregular substrates. While the best method is determined by the material and application at hand, for many automated fluid dispensing processes high-speed jetting technology is a popular alternative to traditional, needle-based contact dispensing.

With high-speed jetting, the jet valve never contacts the product or substrate surface. This offers a higher degree of flexibility and can be used in a wider variety of applications otherwise requiring a Z-axis system with height-sensing and positioning functionality. These distinguishing features provide advantages in dispensing speed and agility, dot capability and quality, maintenance, throughput, and cost of ownership.

High-speed jetting is possible by piezoelectric (piezo) technology enabling this style of jet valves to dispense fluids at speeds up to 1,000Hz. Modular piezo jet valves can be configured for multiple uses, combining the benefits

of high-speed jetting, piezo technology, and application flexibility. This makes them a powerful alternative to traditional dispense valves, often limited to a single application capability.

Benefits of jetting include:

- Highly precise, repeatable deposits independent of part topography, tolerance
- Continuous speed dispensing up to 1,000 deposits per second
- Jets from any direction, including horizontal and upside down
- Meets exact deposit tolerances as small as ±1%
- No contact with the surface while dispensing, eliminates substrate damage
- Laser-based light barriers can count every deposit jetted; adds a level of process verification, quality control not possible with contact dispensing
- No contact with substrate surface eliminates dispense tip damage
- Jet valves can create patterns not possible with needle dispensing

### Precise dispensing required

Depositing very small, precise amounts of fluid is an ever-increasing necessity for manufacturers of point-of-care diagnostics and near-patient testing products.

Point-of-care diagnostics and near-patient testing products help doctors make critical decisions, and help patients monitor health. The production of most diagnostic analyzers is meticulous and requires precise dispensing operations to ensure correct functioning of the final product. Jetting is recommended because of the extreme accuracy and reliability it delivers.

One system performing well for this application is Nordson EFD's PICO Pulse XP jetting system due to its fast-dispensing speed and extremely high precision.

Despite the superior performance of piezo jet valves, too often manufacturers see changes in piezo dispensing performance in applications where it's critical the correct amount of adhesive, sealant, or coating is applied consistently. These variations can become evident when there's even a slight change in the tolerance of a jet valve's internal geometry. One jet valve may produce a slightly different dispensing outcome than another with the same dispense settings.



Manual application of assembly fluid onto a medical balloon using an UltimusPlus II fluid dispenser and disposable syringe.

This is why dispensing outcomes can sometimes change after a fluid body is removed, cleaned for maintenance, and then returned to the valve.

This PICO Pulse XP jetting valve system resolves these issues. It's designed to maintain precise, repeatable non-contact

fluid dispensing valve-to-valve, after maintenance, and regardless of external factors such as temperature changes.

PICO Pulse XP also sets a stroke range and measures the distance between the open position to the closed position of the valve. Its Sustained-Stroke Target

Seeking functionality permits the valve to self-adjust to maintain a micron-level stroke setting for long periods, regardless of environmental conditions. Sustained-Stroke Target Seeking monitors and regulates the slightest variation in stroke range, ensuring the release of a consistent amount of fluid for the correct dot size. It maintains optimal jetting results, even after maintenance, achieving micro-deposits as small as 0.5nL with extreme precision and repeatability at up to 1,000Hz (deposits per second) continuously. (See sidebar for examples)

## Vision-guided robotic dispensing

Vision has been used in fluid dispensing applications for more than two decades and is becoming more prominent as robots and control software get smarter. It permits robotic fluid dispensing systems to deliver faster production cycles, removing guesswork from the dispensing process, minimizing programming time, and reducing overall operational costs.

The latest fluid dispensing robot systems – Nordson EFD's GV, RV, EV, PRO, and PROPlus Series models for 3- and 4-axis applications – with advanced software and vision-guided capability, bring repeatability and precision to automated dispensing systems and assembly operations. Well-suited for dots, lines, potting, damming, filling, underfilling, encapsulation, sealing, coating, and jetting – syringe-based and valve-based – these systems handle a range of applications from inline to batch dispensing.

In robotic dispensing when very fast, high-resolution photos of substrate parts are needed, a charged-coupled device (CCD) camera would be required. The camera functions by taking a picture of a part on the substrate and applying any necessary offsets by adjusting the dispensing program to match the location and shape of the path with the location and shape of the component. The camera verifies the location of a component by identifying a distinguishing edge that can be referenced. That reference point allows dispensing software to offset fluid dispensing if the point changes location – such as if the substrate registration is slightly displaced when positioned in the robot – and applies that offset change to where the dispensing is now to be



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## PICO Pulse XP application examples

When dispensing a UV-cure adhesive to assemble blood gas analyzers the PICO Pulse XP would be more efficient and accurate than using benchtop dispensers to assemble the readers by hand.

PICO Pulse XP is the choice when dispensing reagents onto blood test strips. The chemistries must be dispensed only on certain sections of the strip, so when the blood or test sample is added to the sample pad, the right antibodies and antigens are latching onto the sample to provide an accurate test result.

PICO Pulse XP works with vaccine manufacturing for dispensing dots and beads of paint on ampoules to indicate the medical material inside. Clarity is critical in ampoule manufacturing so medical professionals can easily identify the contents of an ampoule.

placed on the substrate. This capability is enabled by DispenseMotion advanced vision-guided software from Nordson EFD.

### Benchtop fluid dispensing

The nature of medical devices sometimes warrants a more personalized and manual fluid dispensing approach in assembly compared to employing a more automated, robotic system. Often, the geometry of parts is too complex to make robotic automation a viable option or production volume is too low to warrant the investment.

Because benchtop fluid dispensing has proven to be a highly workable and reliable method for assembly of medical devices, fluid dispensing manufacturers have routinely improved and refined systems. Pneumatic benchtop fluid dispensing has taken a considerable leap forward in simplicity, ease of use, and improved process control, further supporting strict requirements of life sciences manufacturing.

Nordson EFD's UltimiusPlus line of pneumatic benchtop dispensers were designed to meet the stringent fluid dispensing needs of today's highly precise medical device manufacturing.

These improvements are designed to:

- Facilitate easier, more efficient operation of the fluid dispensing process

- Maintain better process control over dispensing parameters for consistent outcomes
- These latest changes also bring semi-automated desktop fluid dispensing into compatibility with Ethernet, the Industrial Internet of Things (IIoT), and

the cloud, enabling the potential for more direct machine/process interconnectivity. Although this is particularly valuable where benchtop fluid dispensing systems are used in combination with robotic dispensing applications, aspects of this enhanced connectivity can

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Advanced micro-dispensing technologies can deliver extremely tight deposit tolerances that are within 1% of project specification for size, height, and shape of the microdots.

be beneficial to non-robotic pneumatic benchtop fluid dispensing – enabling benchtop dispense technicians to begin to benefit from smart-factory digitization.

Key unique capabilities integrated into this latest evolution of benchtop fluid dispensers include:

**Automated pressure regulation with full operator lock-out:** In medical device assembly, it's critical the fluid dispensing be administered precisely and in the same repeatable pattern on each component with repetitive standardizations.

Typically, fluid dispensers allow the operator to manually adjust pressure regulation. On some of the latest benchtop fluid dispensers, the operator can now be fully locked out from manually adjusting pressure regulation and other dispense parameters such as time and vacuum settings. Without access to an assigned password, the operator can't change the dispense program parameters, eliminating process inconsistencies caused by operator-to-operator variability.

**Facilitating faster setup and integra-**

**tion:** UltimatusPlus is equipped with a USB drive, permitting reports to be output onto a flash drive and enabling distribution of dispense programs into and out of the dispenser. This can considerably cut programming time when multiple dispensers are set up to dispense the exact same parameters on the same parts. One dispenser can be set up with multiple programs, those parameters then output to a flash drive and loaded into the other dispensers, minimizing human error and expediting loading of dispense programs across the factory floor.

Also speeding fluid dispensing setup and operation for medical device manufacturers is human machine interface (HMI) touchscreen control for input of dispensing parameters and management of all dispensing process functions, making setup significantly faster than with analog knobs and hand push-button controls.

The dispense cycle can be initiated by a centralized, customer-site-specific programmable logic controller (PLC) as

part of a large, in-line operation. When the production line needs to move from making one type of part to another, the PLC will remotely trigger the dispenser to change the program and dispense a different deposit pattern. In addition, manufacturers with their own output monitoring program can edit the PLC programs, enabling a closed loop control process.

## Optimizing fluid dispensing performance

Many factors can impact fluid dispensing for the assembly of medical devices, point-of-care diagnostics, and near-patient testing products. Lab testing, prior to installation, is a crucial step in the process of selecting the most applicable system. Consulting with an application specialist early in a project will ensure the right fluid dispensing system is used and the most optimum process put in place. This will facilitate manufacturing to achieve the desired production capacity and optimized process control. D&A

