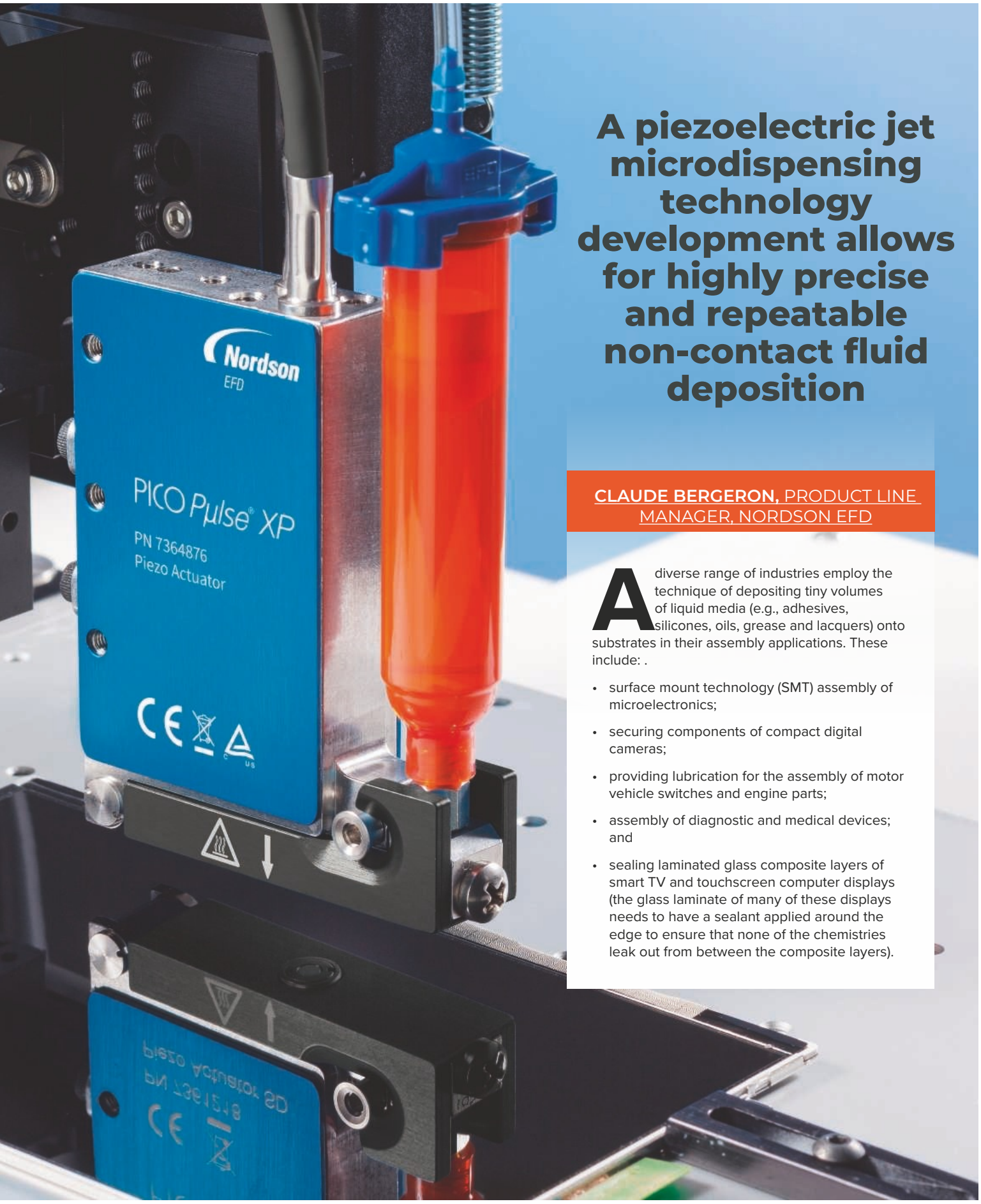
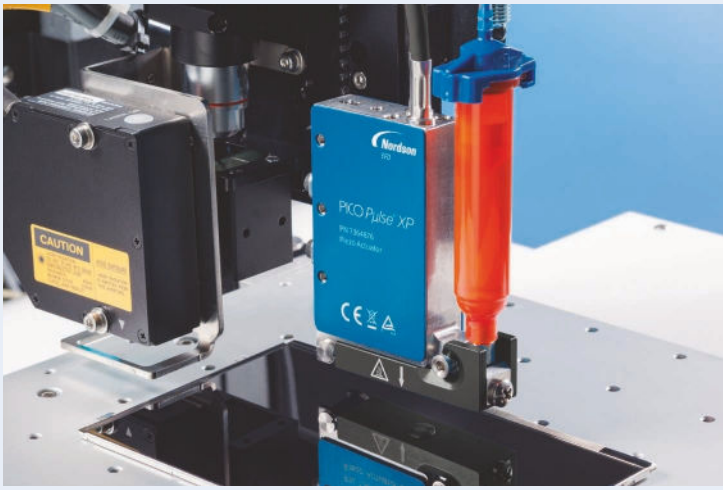


A piezoelectric jet microdispensing technology development allows for highly precise and repeatable non-contact fluid deposition

CLAUDE BERGERON, PRODUCT LINE MANAGER, NORDSON EFD

A diverse range of industries employ the technique of depositing tiny volumes of liquid media (e.g., adhesives, silicones, oils, grease and lacquers) onto substrates in their assembly applications. These include: .

- surface mount technology (SMT) assembly of microelectronics;
- securing components of compact digital cameras;
- providing lubrication for the assembly of motor vehicle switches and engine parts;
- assembly of diagnostic and medical devices; and
- sealing laminated glass composite layers of smart TV and touchscreen computer displays (the glass laminate of many of these displays needs to have a sealant applied around the edge to ensure that none of the chemistries leak out from between the composite layers).



▶ The PICO XP piezoelectric jetting system can be used to seal the laminated glass composite layers of displays. ▶

The tiny amounts of fluid must be deposited precisely and repeatably in terms of dosage and placement, these factors being critical to the assembly, function, quality, appearance and viability of these products.

Jet microdispensing

Microdispensing has evolved to support higher throughput assembly production, namely through the development of specialised microdispensing technology for automated, inline assembly and manufacturing systems, and standalone production devices.

Jet microdispensing is a non-contact method of depositing tiny and extremely precise amounts of fluid with high repeatability. In most applications, a series of fluid microdots is put down, and these microdots stitch together, blending seamlessly to form a continuous line or any shape. The dots are 300–400 µm in diameter and have extremely tight deposit tolerances, namely within 1 percent of project specification for size, height and shape.

"High-speed jetting is made possible by piezoelectric jet valves that dispense very discrete, highly precise microdots at speeds of up to 1,000 Hz."

The jet valve never touches the product or substrate surface, thus eliminating substrate and dispense tip damage. Moreover, a higher level of flexibility is possible and it can be used in a wider variety of applications that would otherwise require a Z-axis system with height-sensing and positioning functionality. Laser-based light barriers can count every deposit jetted, adding a high level of process verification and quality control. These distinguishing features provide advantages in dispensing speed and agility, dot capability and quality, maintenance and throughput.

High-speed piezoelectric jet valves

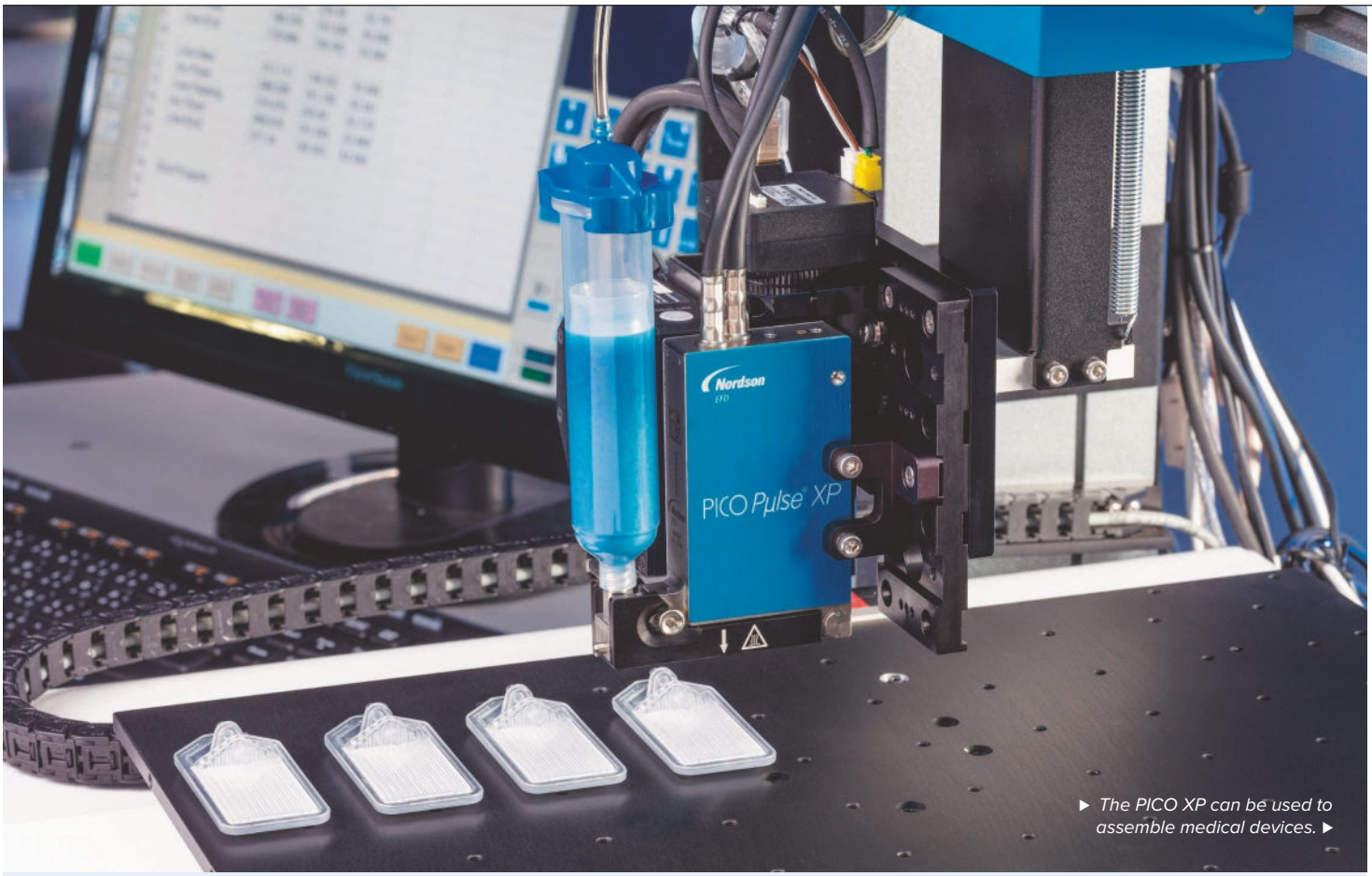
High-speed jetting is made possible by piezoelectric jet valves that dispense very discrete, highly precise microdots at speeds of up to 1,000 Hz. Modular piezoelectric jet valves, which can be configured for multiple uses, combine the benefits of high-speed jetting and application flexibility.

Piezoelectric jet valves can achieve extremely fast open-and-close cycles that eject, or jet, fluids onto a substrate. When pressure is applied to certain materials—such as layered structures of specialised lead zirconate titanate (PZT) ceramic stacks interleaved with electrodes—it creates voltage. Conversely, when voltage is applied to PZT, it changes its shape. In the case of piezoelectric jet valves, voltage is applied to a piezoelectric actuator inside the valve. The applied voltage causes a bulk change in the ceramic's length, allowing the actuators to be used for fast, high-force, real-time position control at the nanoscale level.

Piezoelectric jet valve dispensing performance

Despite the superior performance of piezoelectric jet valves, too often manufacturers see changes in dispensing performance in applications where it is critical that the correct amount of adhesive, sealant or coating needs to be applied consistently. These variations can become evident when there is 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. This is also why dispensing outcomes can sometimes change after a fluid body is removed, cleaned for maintenance, and then returned to the valve

A piezo stack in a valve is capable of running for hundreds of millions of cycles, even billions of cycles, long after a jet valve with mechanical components has ceased to operate. However, as it opens and closes during initial startup, the piezo jet valve, like all dispensing valves, heats up; and as it heats up, the valve changes the property of the piezo stack actuator and how much it moves given the same input. The amount of movement will change from the beginning of the dispense



▶ *The PICO XP can be used to assemble medical devices.* ▶

cycle to the end. The actual physical distance that the stroke travels will increase because of the change in temperature. If the valve runs for an hour, it will eventually produce bigger dots. The net result is a diminishment in repeatability.

In 2021, Nordson EFD introduced the PICO Pulse XP piezoelectric jetting system, which affords a significant technology development, namely correcting the temperature change naturally occurring from the exercise of the piezo actuator. This development has had a considerable influence on the stabilisation of piezo jet valve repeatability. The PICO Pulse XP is designed to maintain precise, repeatable non-contact fluid dispensing valve-to-valve, after maintenance, and regardless of external factors such as temperature changes.

Self-regulating calibration

Conventional jet-valve fluid dispensing applications operate on a stroke range of about the thickness of a sheet of paper, controlling the stroke to maintain consistent valve-to-valve repeatability. Essentially, the operator sets the stroke range and hopes the system will maintain those parameters. However, these settings can be influenced by temperature changes, which can modify the amount of fluid dispensed. How far the valve is opened will determine the amount of fluid released and the size of the deposited dot.

The PICO Pulse XP also sets a stroke range as well as 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 such as ambient temperature changes, which can alter dispense results over time.

Sustained-stroke target seeking monitors and regulates the slightest variation in stroke range to ensure 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 0.5 nl, with extreme precision and a repeatability of up to 1,000 Hz (deposits per second) continuously.

To achieve this more precise level of operation, the PICO Pulse XP utilises a sensor that can measure down to 0.10 µm of the displacement of the stroke and make movement adjustments down to 0.25 µm to the valve stroke. Additionally, fluid temperature is controlled with a heating system able to maintain a very close tolerance of +/- 0.07 °C temperature variation.

Micron-level stroke adjustment

Typically, with jet dispensing, operators will experiment to achieve good dispense settings or even to determine the dot size needed for a singular dispense setup, then follow the same procedure for similar jet dispensers on a line where multiple fluid dispensing cycles are occurring. Trying to achieve the same size dot may require tweaking of the stroke for each device. This can pose a challenge, as every part that goes into each valve has a tolerance, and even the piezo stack itself may have a slightly different coefficient of expansion, which can lead to fairly

▶ The PICO XP features a touchscreen user interface for ease of use. ▶

significant differences from valve to valve, with influence on the valve movement throughout a dispensing timeframe.

The PICO Pulse XP resolves this issue through micron-level stroke adjustment, which fine-tunes jetting performance for a wide range of applications. The stroke distance valve to valve and controller to controller is maintained throughout the dispensing cycle due to it being consistently measured and standardised.

Simplified setup and maintenance

The PICO Pulse XP's self-regulating calibration and micron-level stroke adjustment enable fluid dispensing to start almost immediately. Fluid assemblies can be removed and fresh ones installed without having to reset dispensing parameters.

The valve's quick-release clasp allows for tool-free removal of the fluid body for simplified cleaning of the fluid path, which cuts time during maintenance. Moreover, the valve can be outfitted with one of several fluid bodies available with different properties and orifice sizes to meet manufacturers' application requirements.

Sustained repeatability equals process control

Shot-to-shot precision and repeatability are critical factors in fluid dispensing. The ability to deposit very small and precise amounts of fluid is an ever-increasing necessity for manufacturers. The piezoelectric jet microdispensing technology development outlined above meets these requirements with the capability to dispense these fluids with higher sustained repeatability, which equates to better process control. ●

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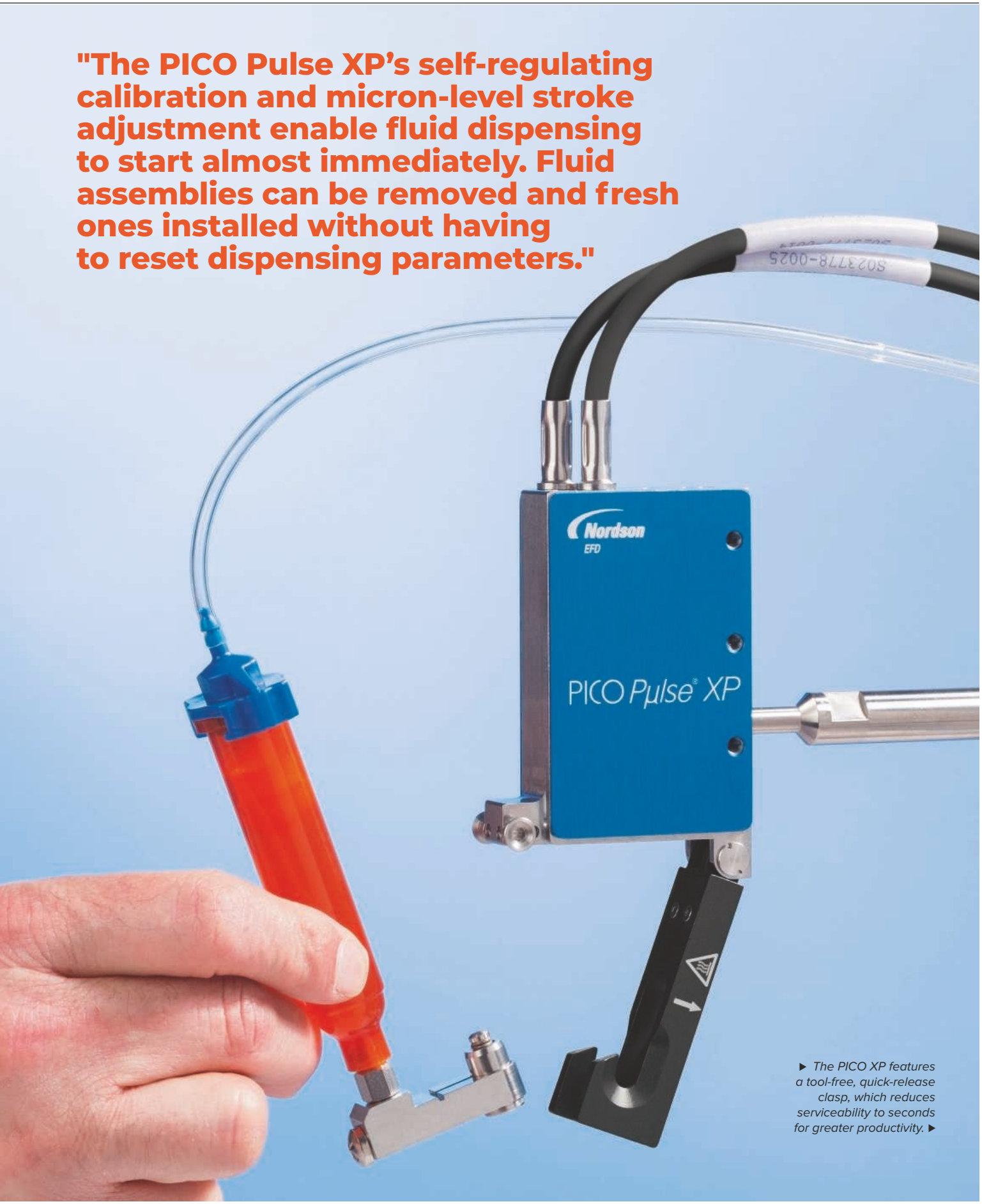

▶ The PICO XP features a tool-free, quick-release clasp, which reduces serviceability to seconds for greater productivity. ▶