VersaForce™

PRECISE • RELIABLE • EFFICIENT • SAFE • SMART

Clinch Press Solutions

centerline®

Ver. 1.0

CenterLine (Windsor) Limited

CENTERED ON SOLUTIONS

VersaForce™ CLINCH PRESS SOLUTIONS

The VersaForce™ Clinch Press is an integration ready solution. A servo pump controls every aspect of the cylinder motion, including the Intensification Piston Force Signature.

CenterLine's Air-over-Oil Cylinder has been re-imagined. A closed oil system replaces the air with oil. A servo motor controls the pump, which quickly advances the ram and decelerates for a soft touch, verifying the fastener before precisely controlling the clinch force profile. A directional valve is used with the servo pump to control the intensification cylinder sequence.

*Precise control of the **Force Signature** with **Smart Process Analytics***

VersaForce™ Delivers Unmatched PRESS Capabilities

P	R	E	S	S
Precise	**Reliable**	**Efficient**	**Safe**	**Smart**
Closed-loop feedback ensures consistent force and position control.	Proven cylinder construction for long-term durability.	The servo control optimizes the power required on demand.	The positive displacement pump with Servo Drive Safe Torque Off (STO) provides a zero energy state.	High-resolution force signature analysis for process insights, monitoring and alerting.

Patent: www.cntrline.com/patent.

System Core Elements

Servo Power Unit

- Power-on-demand for efficient operations
- Servo driven pump
- Closed oil system
- Built in STO drive

Intensification Cylinder

- Inverted feed process capability with 90-degree cylinder option
- Proven reliable design
- Compact and fit to application requirements
- Simple design for minimal maintenance.
- High pressure is isolated in the cylinder

SoftMount™ Clinch Press

Integration Ready Panel

- A dedicated controller is needed to achieve the high sampling rate required to generate the fastener clinch force vs. distance profile analytics.
- The servo drive is pre-tuned to optimize the velocity and torque control for precise fastener clinch force.

VeriFast™ SA (Signature Analysis)

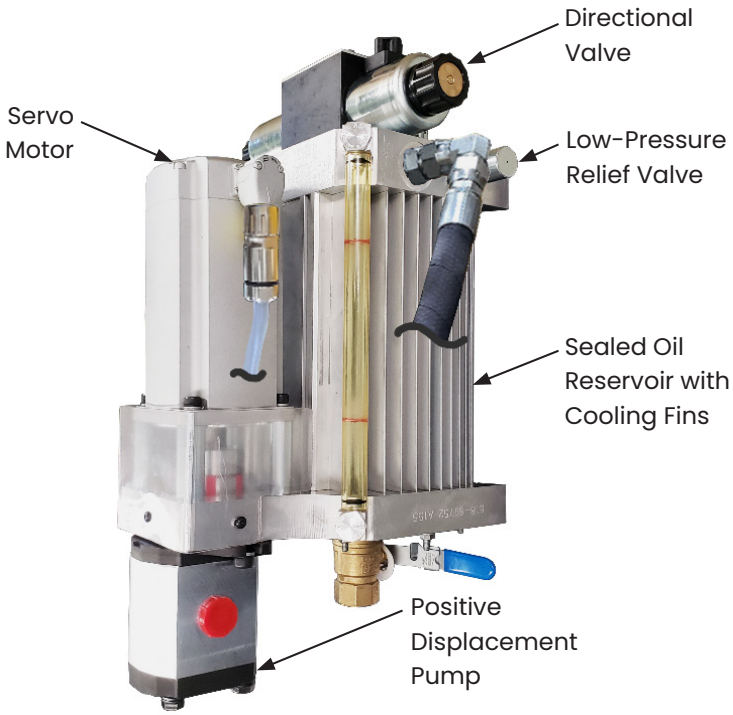
VersaForce™ developed software for process visualization of the clinch signature to aid in optimization, insights and monitoring.

Features and Benefits

- A simple design with limited number of moving parts allows for reduced maintenance costs and keeps downtime to a minimum, unlike other linear servo actuators.
- Tune the speed to optimize the clinch process and force signature analysis.
- Efficiently delivers a wide force output range, within a few cylinder models.
- Configurable maximum and minimum force and position limits.
- Partial retract and advance capability for custom motion requirements.
- Soft-touch control to verify the fastener presence and minimize tooling wear.
- Optimized cycle time from the rapid low-pressure advance and short intensification force stroke.
- CenterPoint™ production monitoring enabled, allowing for real-time process tracking.
- Proposition 65 - Chemical Exposure Warnings Law - Shell Tellus S V22 does not contain any substances explicitly listed under California Proposition 65.
- **Saves up to 10.5 million standard cubic feet of air consumption per year compared to pneumatic alternatives.**

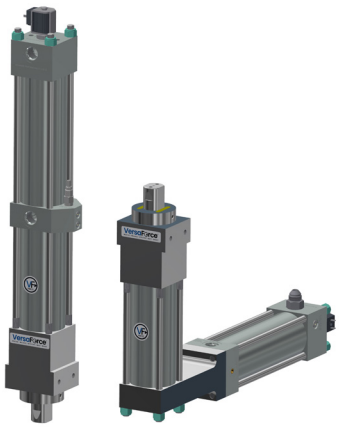
VersaForce™ Actuator System

Intensification Cylinder



Servo Power Unit

Intensification Cylinders

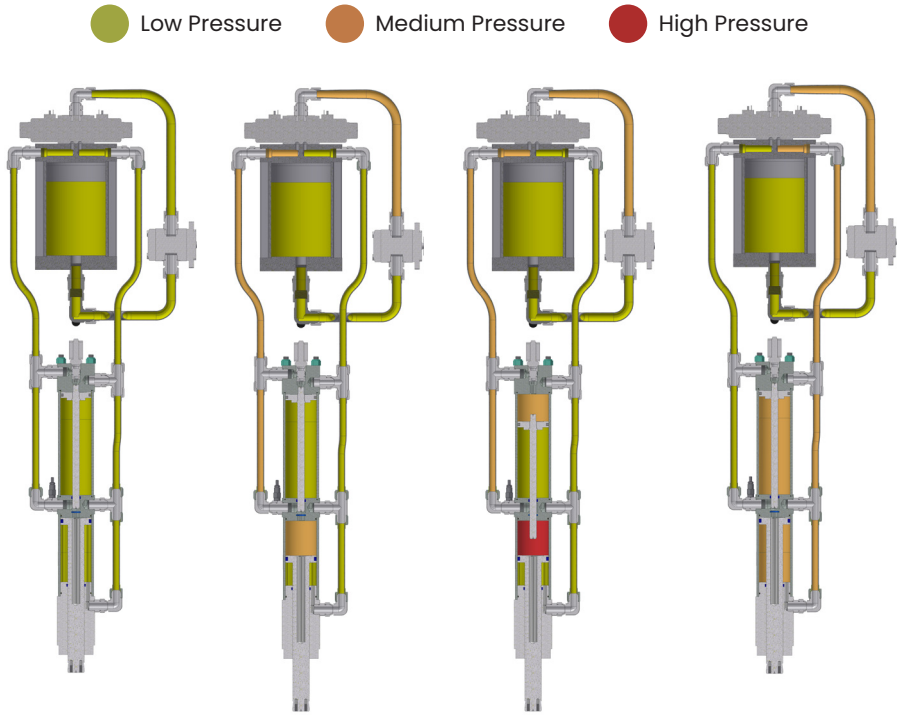
2″ Bore Maximum Force: 10,000 lbf	3-1/4″ Bore Maximum Force: 30,000 lbf	5″ Bore Maximum Force: 70,000 lbf
		

Available Orientations:	Straight with Standard Feed Process	90° with Inverted Feed Process

Cylinder Sequence of Operation

The VersaForce cylinder features a precise two-stage motion for optimized speed and force. The servo-driven positive displacement pump controls the fast-closing first stage, which decelerates to a soft-touch close on the clinch fastener.

The VeriFast Smart Pin and LPT verify fastener and material presence before the valves are used to switch to the high-force intensification stage. During intensification, the piston delivers controlled high-pressure force, with feedback from the LPT and oil pressure sensor ensuring accurate force vs. position monitoring of the clinch process.



Smart Process Technology and Industry 4.0

VeriFast™ Signature Analysis

VersaForce enhances process intelligence by capturing high-resolution force vs. position data during every clinch installation cycle. Signals from the integrated force sensor and LPT are sampled at approximately 5 ms intervals, generating a detailed process signature for each installation.

To establish monitoring limits, a reference dataset, called the **VeriFast™ SA (Signature Analysis)** Teach Window is created using a series of validated installations. These signatures are normalized and segmented as a percentage of the clinch stroke, accounting for small process variations. Each segment is assigned a user-defined force tolerance and forms a multi-zone envelope known as the VeriFast SA Tolerance Window, which future cycles are verified against.

If a segment falls outside the Tolerance Window during a cycle, the workpiece is flagged as a failure, clearly indicating that the signature deviated beyond acceptable limits and that notable process differences have occurred. Beyond a simple pass/fail response, the VeriFast SA continuously monitors and reports a process score, offering insight into how closely and consistently each clinch signature tracks within the Tolerance Window. This score enables early detection of subtle process shifts helping maintain long-term stability and compliance.

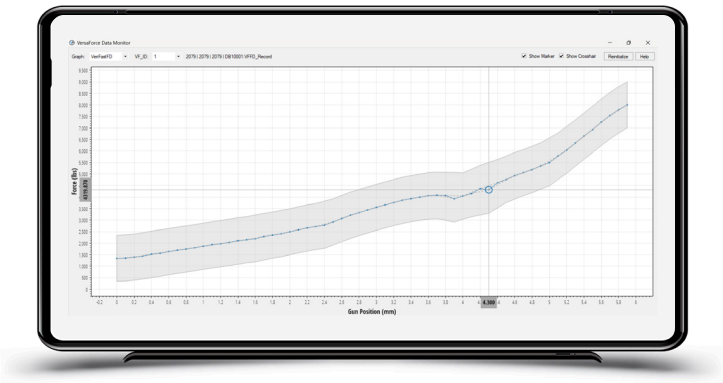


Figure 1: *The VeriFast™ SA Teach Window displays the data range established during the teach process. This range represents acceptable force-distance signatures for successful clinch installations. Any subsequent signatures falling outside this defined zone will be flagged as failed parts.*

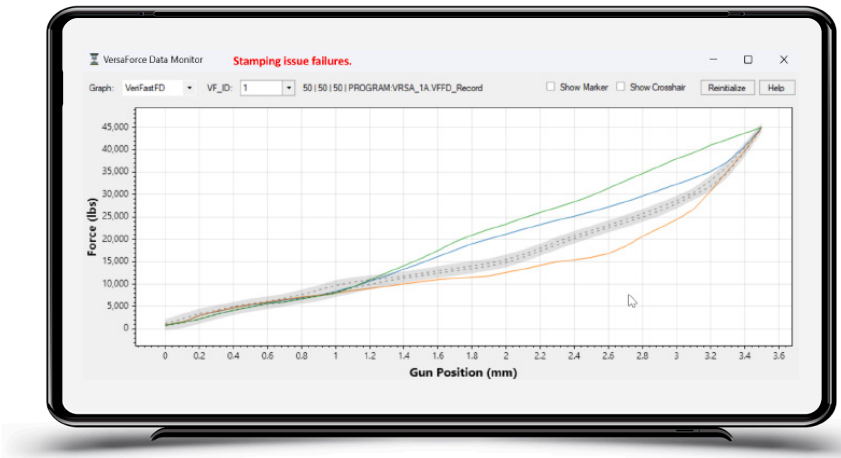


Figure 2: *The graph shows the VeriFast™ SA tolerance band in grey, created based on validated parts, with green, blue, and yellow traces from the failed samples falling outside. All visualized on the VersaForce™ Development Application.*

Non-Conformance Risk Management

During development with a Tier One supplier, VersaForce flagged a stamping revision as non-conforming with multiple failures, even though visual inspection showed no clear defects. VeriFast SA process monitoring technology sensed the force vs. distance signatures fell outside the Tolerance Window, prompting further destructive testing and investigation. The test confirmed that the parts failed to meet specifications. This early detection enabled the customer to trace the issue back to a stamping process change, helping to avoid a potential non-compliance event.

Process Development App

The VersaForce Process Development Application is a PC–based application designed for setup, tuning and diagnostics, providing a tool to optimize cycle time, and develop the clinch profile to visualize force signature overlays and analyze cycle dynamics in detail.

The application allows users to view force vs. displacement data in real time and compare it against the Tolerance Window. Time-based graphs of force, position, and servo response provide deeper insight into each cycle's behavior.

While not required during production, the application is invaluable for:

- Troubleshooting installation issues
- Optimizing clinch performance
- Making informed PID tuning adjustments

Production Monitoring with Proactive Alerting

CenterPoint™ is an advanced IIoT production monitoring solution within the CenterLine product family, designed to deliver real-time visibility into machine performance. Through intuitive dashboards, automated notifications, and detailed reports, CenterPoint reduces reliance on manual tracking and enhances process transparency.

For VersaForce Solutions, CenterPoint provides specialized dashboards that visualize key clinching process data. Each dashboard contextualizes process metrics, enabling direct comparison of clinch parameters across every part produced.

Key Process Data

- **Clinch Position Details:** ram and pin set points, tolerance bands, and positions.
- **Clinch Force Details:** force when closed on the fastener and peak force recorded during clinch.

In contrast to the continuous force-displacement plots shown earlier, the graphs on the next page display specific force and position values at a specific moment in time during the machine cycle. This results in relatively flat lines, which reflect the expected consistency from part to part.

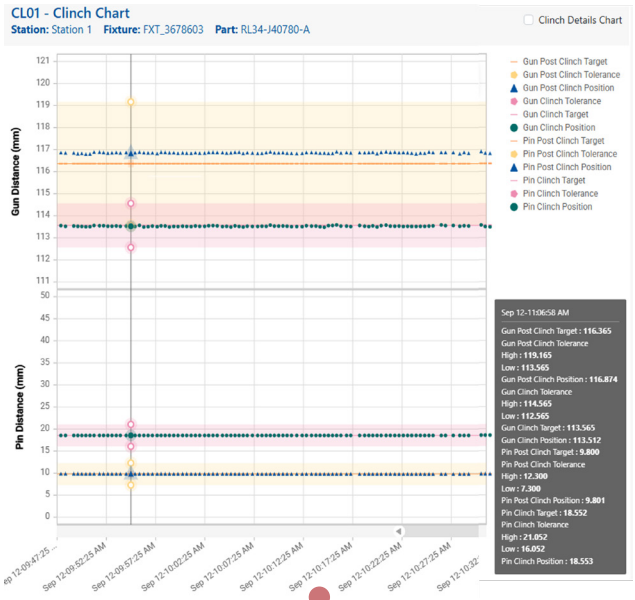
Machine Efficiency

- **Machine Cycle Times by Hour:** detect process trends and deviations early and improve equipment uptime and reliability.

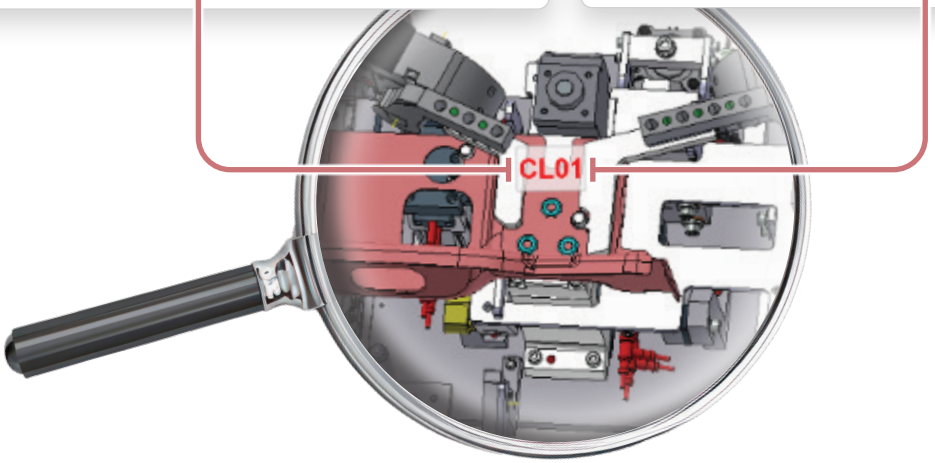
CenterPoint transforms clinch monitoring from reactive to proactive—delivering actionable process insights, consistency, machine efficiency and reduce scrap.

CenterPoint™

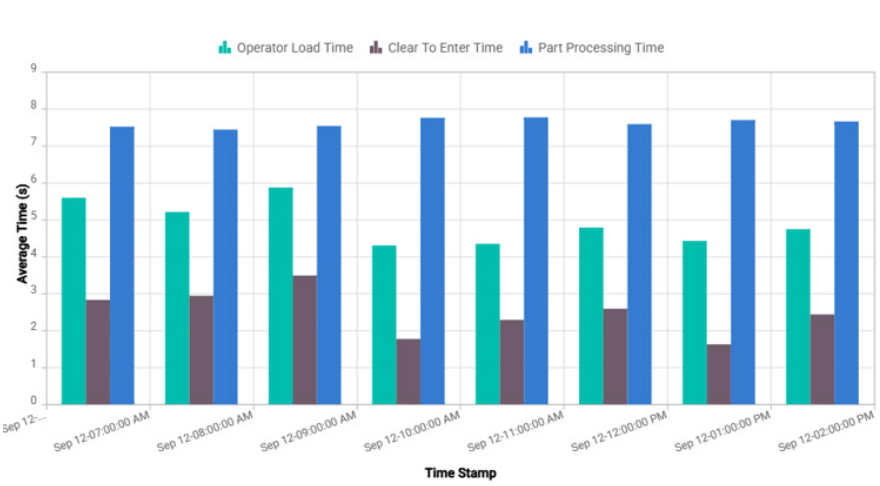
Clinch Position Details

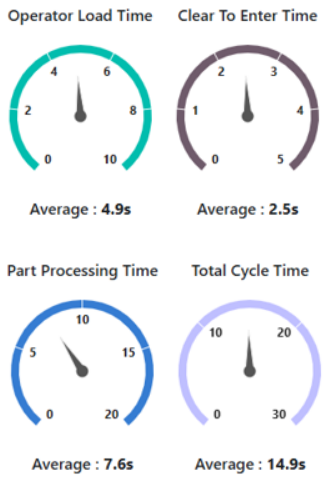


Clinch Force Details



Machine Cycle Times by Hour





Process Innovation and Cycle Time Savings

Cumulative Financial Impact Over the Life of a Program

We continually innovate our products to add value for our customers. Machine cycle time reduction is always a focus; even the smallest time savings have a significant cumulative financial impact over the life of a program. We have developed fastener placement devices and processes to **bury the fastener feed time, saving up to 1.5 seconds/cycle**.

Placement Units

Inverted Feed Process (IFP) & Lower Nut Feeder (LNF)

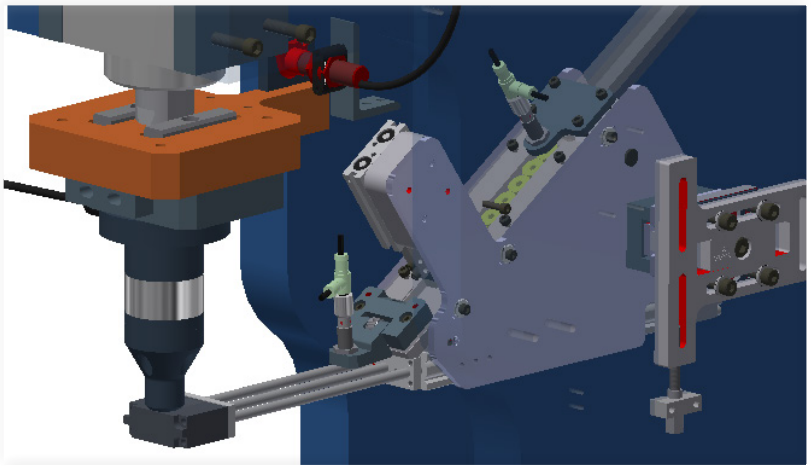
The SoftMount Clinch Press offers an IFP version where the traditional process is inverted. The VersaForce cylinder is mounted in the lower press frame. The fastener is fed inverted to the SmartRam pin using the LNF. A material handling robot then feeds the workpiece to the upper die pin, and the SoftMount Press has finite adjustment to locate and pin the workpiece hole. The SmartRam advances the inverted clinch fastener and presses it into the workpiece.

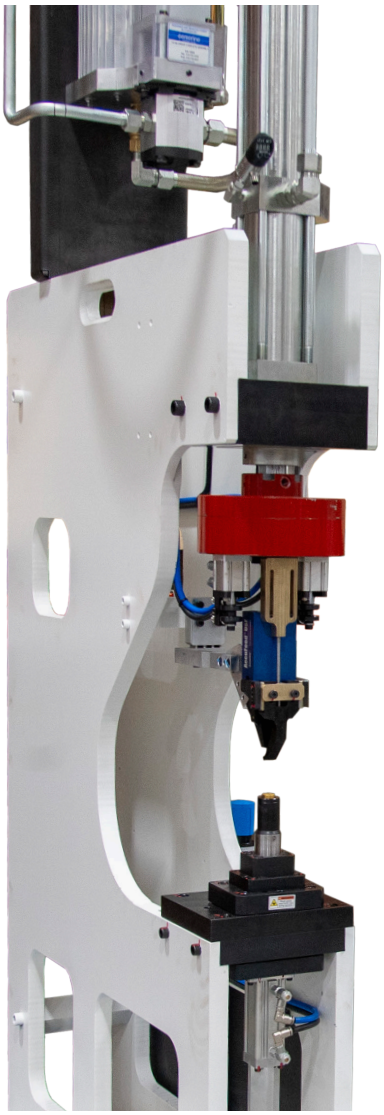
Upper Clinch Stud Feeder (UCSF)

The UCSF can be integrated into the SoftMount Clinch Press SFP, Inline Clinch Press, and FlexFast Clinch Press. The UCSF is mounted to the upper ram. The stud is fed to the UCSF jaws while the workpiece is positioned to the lower die pin. The ram advances with the stud, which is guided into the workpiece hole using the Smart Pin. The UCSF has clamp fingers to hold the workpiece in place until the ram inserts the stud.

Upper Clinch Nut Feeder (UCNF) with SmartRam™ for Slug Management

For self-piercing applications, used on VersaForce Inline and FlexFast Presses. The UCNF feeds a nut to the SmartRam pin, where it is held in position using embedded magnets. The SmartRam has a fastener presence sensor to ensure the fastener is in place for the duration of the installation. As the nut is installed, the SmartRam uses intensification oil pressure to eject slugs from the die by advancing the SmartRam pin. The SmartRam VeriFast IA slug Pin verifies the slug ejection. The UCNF can also be used for applications with pre-pierced holes.





SoftMount™ Clinch Press Standard Feed Process with Upper Stud Feeder

Process Options

Our Applications Specialist will support your project team in deciding on the best process from our extensive solution offerings. It starts with the number of workpieces and CAD, the annual production volume, an overview of the sub-assembly process, and the level of automation. Together, we'll develop a process to optimize capital cost, tooling cost, the number of operators, and floor space, giving you a competitive edge to win new business.

For Robotic Processes

- **VersaForce™ SoftMount™ Clinch Press** - Floating compliant tooling to mechanically fine-adjust its position to a stamped hole.
- **VersaForce™ Inline Clinch Press** - For self-piercing fasteners or pre-pierced hole applications.

For Manual Operated Processes

- **VersaForce™ FlexFast™ Clinch Press** - Fully guarded manually loaded press with interchangeable fixtures, and movable lower platen. For self-piercing fasteners or pre-pierced hole applications.

Fully Integrated Robotic Cell

- **High Speed Fastener Solution™ (HSFS)** - Consisting of an operator-loaded PinPoint™ Solution, which is a part feeding system that can accommodate and buffer different workpiece geometries. A simple pattern matching camera confirms the workpiece and orientation, and a material handling robot picks the workpieces and presents them to projection welders and clinch presses. The HSFS is flexible where new workpieces can be added with minimal integration cost.

Fastener Placement Options

	AccuFeed™ Placement Devices					Tooling
VersaForce™ Press Model	**Lower Nut Feeder (LNF)**	**Rod Nut Feeder (RNF)**	**Upper Clinch Stud Feeder (UCSF)**	**Rod Stud Feeder (RSF)**	**Upper Clinch Nut Feeder (UCNF)**	**SmartRam™ for Slug Management** Self-Piercing Nut
SoftMount™ Press IFP	✓	✓				
SoftMount™ Press SFP		✓	✓	✓		
Inline Press SFP		✓	✓	✓	✓	✓
FlexFast™ Press SFP		✓	✓	✓	✓	✓

= Fastener placement Units that reduce cycle time by up to **1.5 seconds** per cycle.

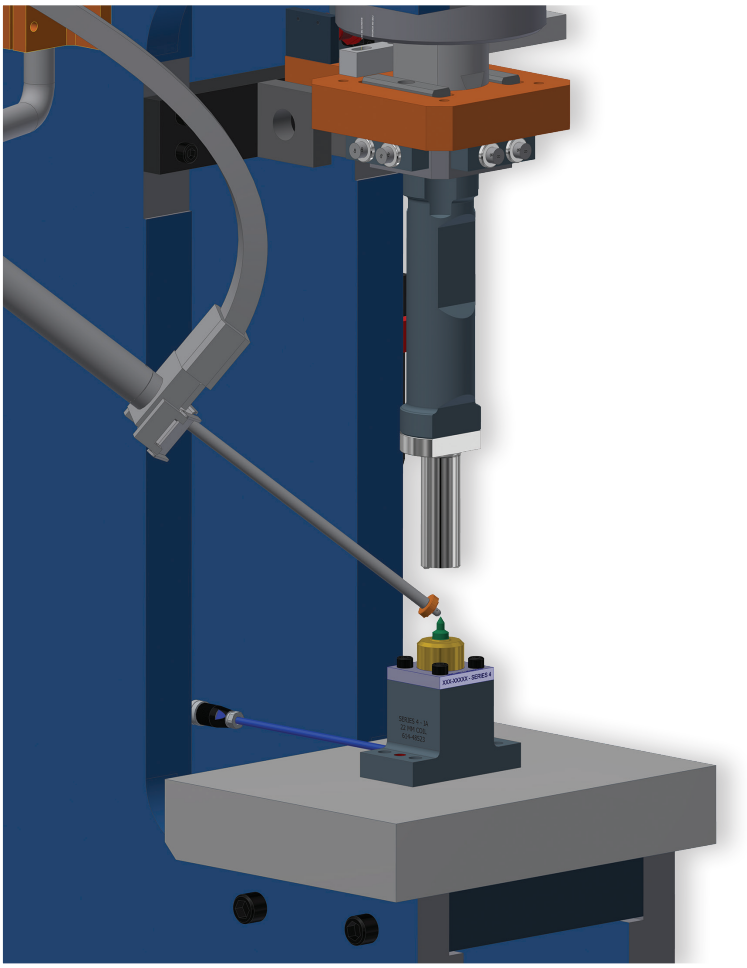
VeriFast™ IA Process Monitoring

Smart Pin Sensing

All fastener clinch presses are equipped with the VeriFast IA Smart Pin sensing system for enhanced process monitoring.

The VeriFast IA clinch body and Smart Pin track the fastener's position throughout its travel. Process values are compared against a taught tolerance band to verify the presence and orientation of both the part and fastener.

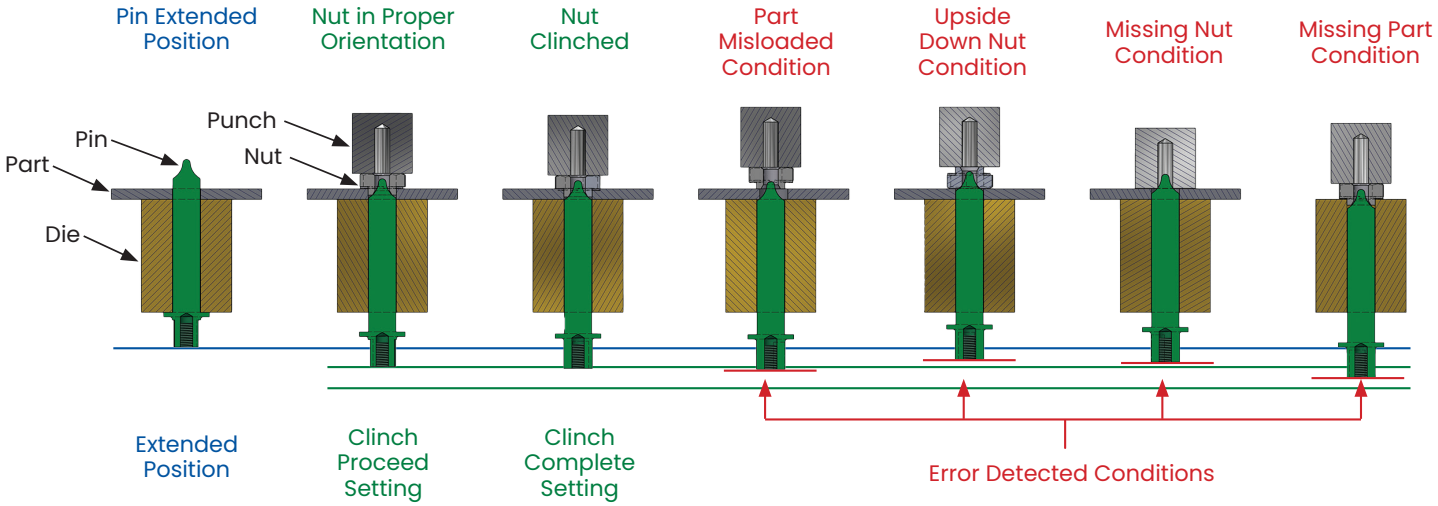
If the VeriFast process values fall outside the tolerance band, the system automatically halts the clinch process, alerting to isolate failed workpieces.



VersaForce™ Press with a VeriFast™ IA Clinch Body and Smart Pin

Set Positions for Presence and Orientation of Fasteners and Parts

The diagram below illustrates various conditions that may occur in a clinch nut application. It highlights the distinction between correct fastener orientation and common error conditions.



VersaForce™ SoftMount™ Clinch Press

The VersaForce SoftMount Clinch Press assists the robot in locating the workpiece hole in-process for installing clinch fasteners. The patented SoftMount technology utilizes floating, compliant tooling **to mechanically fine-adjust to the workpiece**, thereby ensuring the press Smart Pin locates the hole in the workpiece for automated clinch fastener installation. Robotic applications are well-suited for installing fasteners on more than one plane.

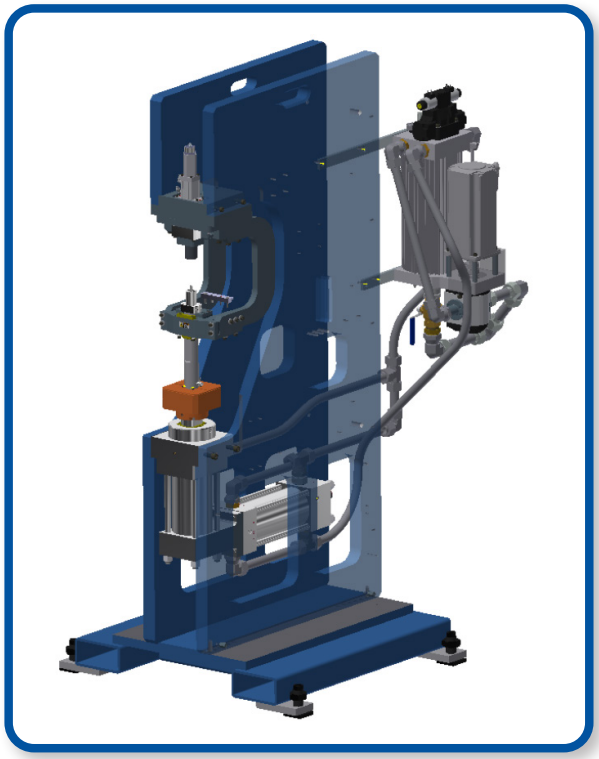
VersaForce SoftMount Press configurations:

- Inverted Feed Process (IFP)
- Standard Feed Process (SFP)

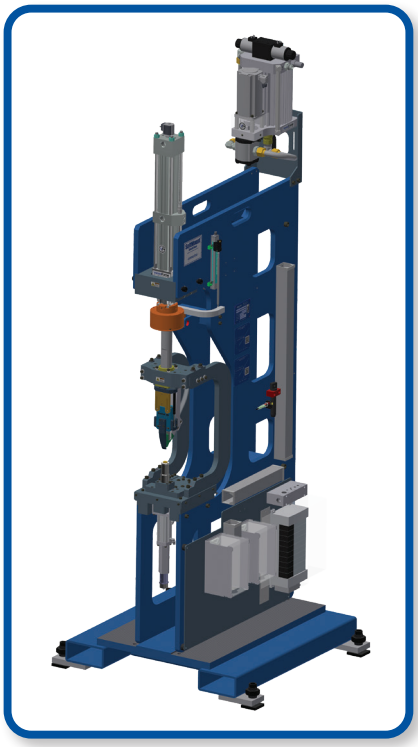
Integration Ready Solution

VersaForce Presses are delivered fully equipped with fastener-specific tooling and integrated controls. Each press is pre-tuned and tested using customer-supplied fasteners and workpieces prior to shipment. Comprehensive documentation is included, including the controls interface template and operational sequence.

All presses include VeriFast IA Smart Pin sensing, which monitors the clinch process. If the VeriFast process values fall outside the tolerance band, the system automatically halts the clinch process, alerting to isolate failed workpieces.



VersaForce™ SoftMount™ Clinch Press IFP 90° Actuator



VersaForce™ SoftMount™ Clinch Press SFP

IFP Configuration

- Installs clinch nuts into pre-pierced workpieces.
- Lower Nut Feeder (LNF) feeds an inverted nut to the lower fastener pin while the workpiece hole is located with the Smart Pin.
- Rod Nut Feeder (RNF) can be used, but no cycle time savings.

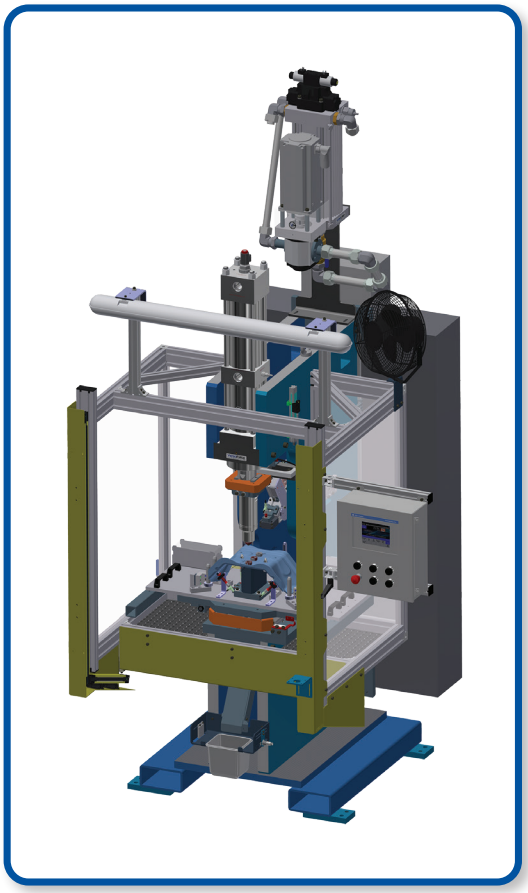
SFP Configuration

- Installs clinch studs or nuts into pre-pierced workpieces.
- Upper Clinch Stud Feeder (UCSF) feeds the stud while the workpiece is located on the lower Smart Pin.
- Integrated clamp secures the workpiece, preventing stamping shift and thread damage during stud installation.
- Rod Nut or Stud Feeder and the LNF can be used, but no cycle time savings.

Fastener feed time is buried, **saving up to 1.5 seconds** per cycle.

VersaForce™ FlexFast™ Clinch Press

The VersaForce FlexFast Clinch Press is a manually operated, turnkey solution designed for various fastener installation options. Its flexible architecture, including a movable lower platen and interchangeable quick-change part fixtures, enables the processing of a wide range of workpieces and fastener types, including both pre-pierced and self-piercing applications.



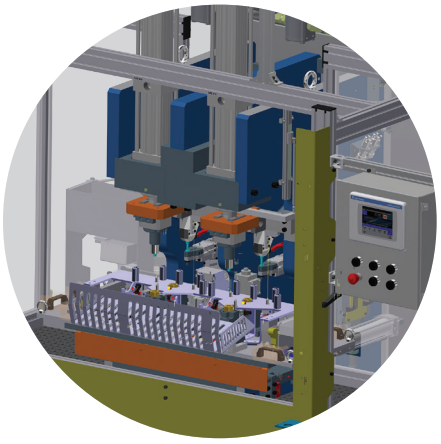
Using your workpiece and fastener CAD, our Application Specialists will work with your team to design fixtures and tooling. We provide the tools and expertise that enable our customers to develop a clinch force signature tailored to meet your push-out and torque-out specifications. A pre-shipment validation workpiece run is conducted to confirm the machine capability and the quoted cycle time.

The FlexFast Press supports installation of:

- Nuts and studs
- Pre-pierced hole applications
- Self-piercing fastener applications

Rapid Changeover & Smart Monitoring

- Tool-less quick-change fixtures allow for changeover in under 5 minutes, including electrical and pneumatic service connections.
- Optional part ejectors reduce cycle time and improve throughput.
- All presses include VeriFast IA Smart Pin sensing, which monitors the clinch process. If the VeriFast process values fall outside the tolerance band, the system automatically halts the clinch process, alerting to isolate failed workpieces.



Multiple Cylinder Configuration

Efficient throughput of left hand and right parts on a single press.

For Pre-Pierced Workpieces

Upper Clinch Stud Feeders (UCSF) and Upper Clinch Nut Feeders (UCNF) are common. Both allow for feeding the fastener in between operations. The UCSF has an integrated clamp to secure the workpiece to ensure neither the stud nor the workpiece is damaged during installation.

- Rod Nut Feeder (RNF) is commonly used, but no cycle time savings.

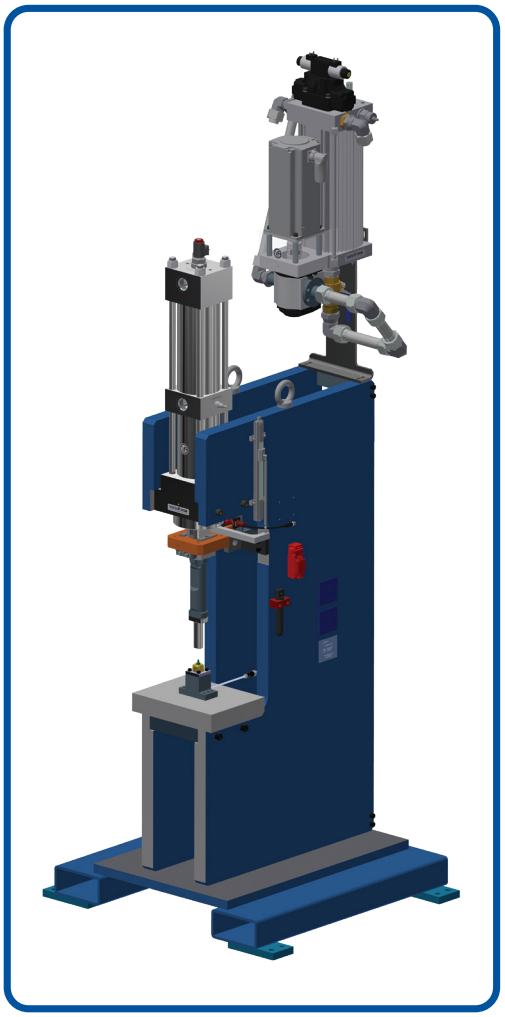
Fastener feed time is buried, **saving up to 1.5 seconds** per cycle.

For Self-Piercing Workpieces

The Upper Clinch Nut Feeder UCNF feeds a nut to the SmartRam pin, where it is held in position using embedded magnets. The SmartRam has a fastener presence sensor to ensure the fastener is in place for the duration of the installation. As the nut is installed, the SmartRam uses intensification oil pressure to eject slugs from the die by advancing the SmartRam pin. The SmartRam VeriFast IA slug Pin verifies the slug ejection.

VersaForce™ Inline Clinch Press

The VersaForce Inline Clinch Press is engineered primarily for **robotic in-process self-piercing fastener applications**. In this configuration, a robot presents the workpiece to the Inline Press and precisely controls the location of each fastener installation.



For Pre-Pierced Workpieces

The stud is fed while the workpiece hole is located below the lower clinch pin. The UCSF has an integrated clamp to secure the workpiece to ensure neither the stud nor the workpiece is damaged during installation.

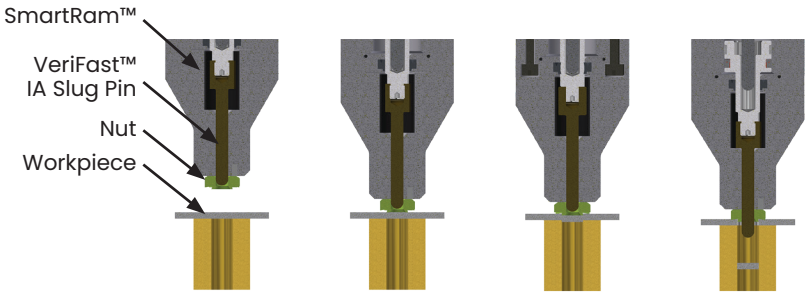
- Rod Nut or Stud Feeder and the LNF can be used, but no cycle time savings.

Fastener feed time is buried, **saving up to 1.5 seconds** per cycle.

For Self-Piercing Workpieces

The UCNF feeds a nut to the SmartRam pin, where it is held in position using embedded magnets. The SmartRam has a fastener presence sensor to ensure the fastener is in place for the duration of the installation. As the nut is installed, the SmartRam **uses intensification oil pressure to eject slugs** from the die by advancing the SmartRam pin. The SmartRam VeriFast IA slug Pin verifies the slug ejection. The UCNF can also be used for applications with pre-pierced holes.

SmartRam™ Slug Management Process

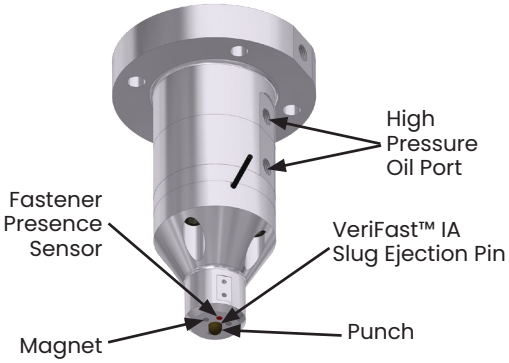


Returned | **Closed** | **Clinch** | **Eject & Confirm**

Clinch nut pierces the material.

VeriFast™ IA Slug Pin advances to clear and confirm slug removal.

✓ Eliminates slug hang-ups, actively monitoring the slug removal process and alerting if the pin doesn't meet full tavel.



SmartRam™

Applications Beyond Fastener Clinching

While VersaForce is widely recognized for its precision in fastener clinching, its capabilities extend far beyond. The system's high-force output, intelligent monitoring, and robust control make it capable for a range of press-based applications, including:

Destructive Testing

VersaForce can be integrated with pushout machines and other destructive testing setups to validate joint strength and ensure compliance with standards. Real-time force monitoring provides detailed insights into failure modes and material behavior.

Multi-Material Joining

Clinch fasteners used to join dissimilar materials (e.g., aluminum to steel) require precise force control and signature validation to ensure joint integrity without damaging softer substrates.

Tog-L-Loc® and Other Mechanical Interlocks

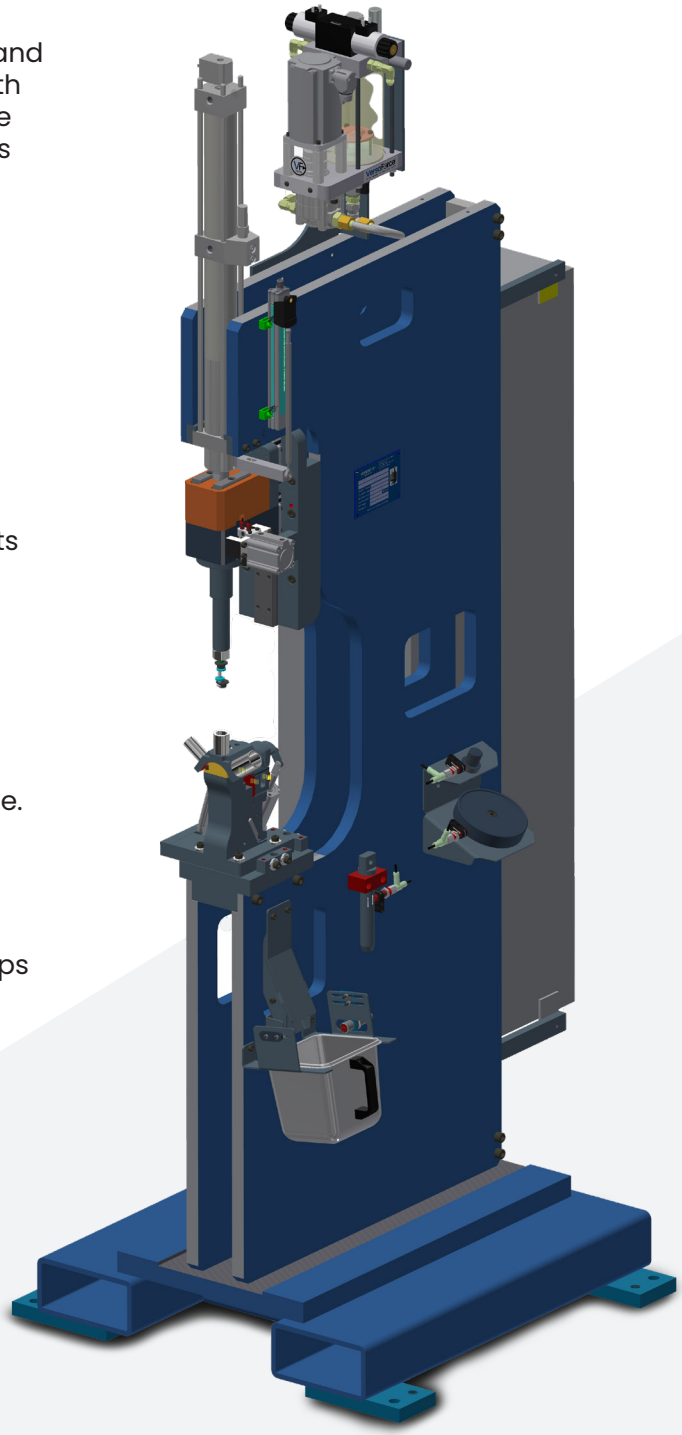
VersaForce supports forming mechanical interlock joints without fasteners. Monitoring force vs. displacement ensures consistent joint formation and quality.

Bushing and Insert Installation

Pressing bushings, bearings, or threaded inserts into components demands accurate force application and position tracking to avoid misalignment or part damage.

Piercing and Coining Operations

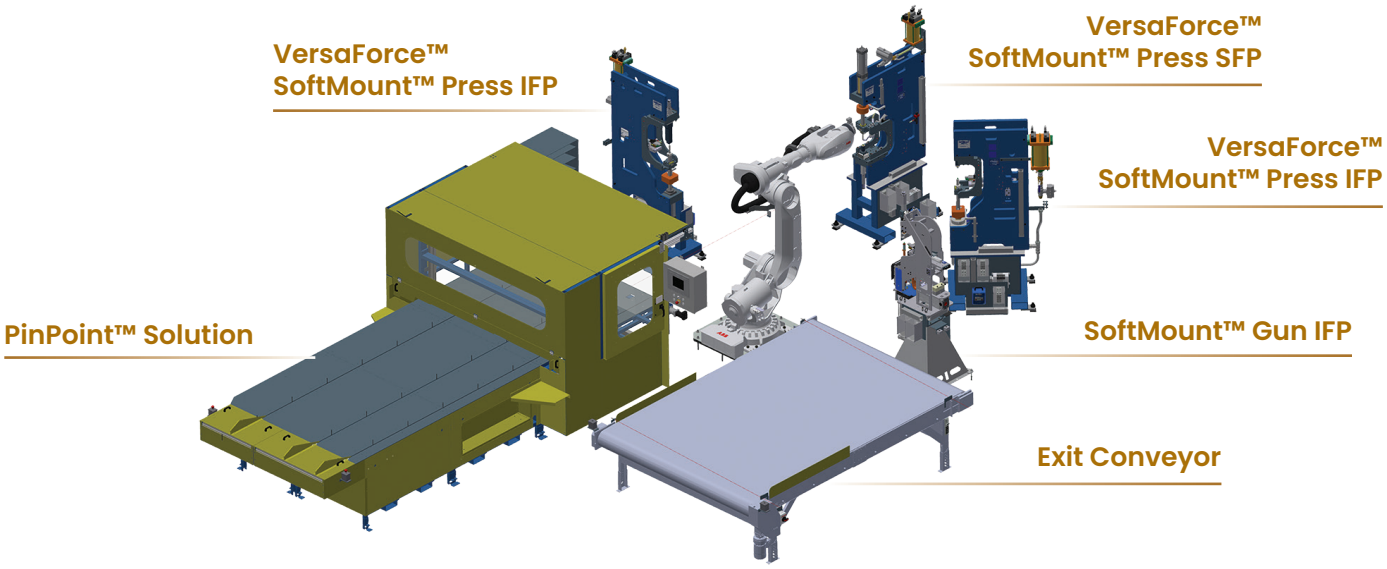
VersaForce can support light-duty forming operations such as piercing or coining, where force monitoring helps validate tool wear and material response.



High Speed Fastener Solution™

Compact. Flexible. Efficient

The HSFS is a versatile robotic cell engineered to streamline fastening operations across a wide range of workpieces. Whether you're handling high-volume production or consolidating low-volume parts, the HSFS delivers unmatched flexibility and efficiency.



High Speed Fastener Solution™ (HSFS)

Key Features & Benefits

- Process High-Volume large workpieces or Low-Volume mix of workpieces.
- The cell can be designed with both Clinch Presses and Projection Weld Guns, or leave space for a future addition.
- The PinPoint does not require expensive workpiece holding fixtures. New workpieces can be added with minimum effort.
- Fill the PinPoint buffer to run through breaks and lunch.
- An integrated FlexFast HD Window Welder, having a large platen, allows many small parts to be fixtured. The robot drops off the workpiece, and the finished workpieces are ejected through the window.
- Automated workpiece bin picking can be evaluated for feasibility.

Operator Independence

- The PinPoint workpiece buffer decouples the operator from the machine's cadence, allowing them to perform other tasks.

Workpiece Validation & Control

- Only complete workpieces exit the cell.
- Suspect workpieces are quarantined inside the cell.

Expandable Functionality

Integrate additional processes such as:

- Drawn Arc Stud Welding
- Workpiece Marking
- Inspection Systems

Collaborative Process Development

You provide:

- Workpiece CAD data
- Production volumes
- Fastener specifications

We deliver:

- A tailored solution to meet your production goals.
- Support to win new business or consolidate existing workpieces.

VersaForce™

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Certain products and technologies described in this document are protected by patents or are patent pending. For more information, visit www.cntrline.com/patent.

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CENTERED ON SOLUTIONS

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