Technology _ Linear friction welding
A strong partner
Linear friction welding is a new process and is a derivative of our rotary technology where we are one of the world’s leading suppliers with more than 1,150 rotary friction welding machines installed in over 44 countries.
Transforming component manufacture

The value of using linear friction welding machines to join a variety of materials is growing rapidly among a wide range of component manufacturers in the aerospace, automotive, medical and power generation markets. KUKA offers the innovation to transform the capabilities of the linear process, it provides the opportunity for significant savings in raw materials, better productivity, lower energy consumption and reduced carbon emissions.
Linear friction welding process

Linear friction welding is a pressure welding process similar to that of rotary friction welding but the movement is replaced by a lateral oscillation allowing non-cylindrical parts to be joined together.

Advantages of linear friction welding

**Very high weld quality**

- High integrity joint quality for complex geometries and almost any type of metal
- Fast bonding technique meets the requirements of any high volume production process
- Complete homogeneous joint

**High weldability of different types of parts**

- Material savings of up to 80% possible through joining of prefabricated components
- Minimal weld preparation for most materials
- Open machine scheme to allow almost any shape to be accommodated

**Additional process advantages**

- Environmentally friendly process with low energy consumption
- No consumables, fillers, fluxes or gases required
- Versatile hydraulic oscillation system
- PC-based control system for weld parameter monitoring
Various material combinations

Diverse material combinations and a variety of joints can be welded in high quality with high material savings.

The process is especially suited to welding any demanding material combinations.

81% material saving

79% material saving

47% material saving

Please contact us to discuss any combinations that are not listed.

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Extensive applications

Thanks to the KUKA Industries linear friction welding machines, a wide variety of components can be joined for many different industries. These include sectors such as aerospace, automotive, medical and power generation.

Typical applications

**Aerospace industry**

- **Components:**
  - Aircraft Structures
  - Landing Gear
  - Various Near Net Shape Components

- **Materials:**
  - Aluminium
  - Steel
  - Titanium
  - Nickel Super Alloys

- **Advantages:**
  - Extreme High Strength
  - Homogenous Bond
  - Minimal machining
  - Time & cost savings
  - Reduction in Energy

**Power generation**

- **Components:**
  - Welding of turbine blades for pre-machining
  - Welding of the blades to the stator on the turbine wheel

- **Materials:**
  - High-performance aluminium
  - Copper
  - Titanium

- **Advantages:**
  - Withstand high temperatures
  - Multiple metal mechanical properties
  - Low electrical connection resistance
Automotive Industry

• Components:
  – Special load bearing monoblocks
  – Combustion Engine Pistons & Valves
  – Driveshafts
• Materials:
  – Aluminium
  – Steel
  – Titanium
• Advantages:
  – Heat and corrosion resistance
  – Weight Reduction
  – Multi-metal construction
  – Elimination of mechanical weak points

Medical

• Components:
  – Bone Structures
  – Specialist Medical Tools
  – X-ray & Cryogenic Components
• Materials:
  – Surgical steels
  – Copper to moly bonding
  – Stainless steel and titanium joining for cryogenic applications
• Advantages:
  – Bonding multiple surgical metals
  – High strength homogenous bond
Broad range of products and services

- Feasibility and process studies
- Trial welds, tool selection and parameter optimization
- Design and construction of part-specific clamping equipment
- Design, manufacture and delivery of production systems
- Integration of linear friction welding processes in automated manufacturing lines
- Quality concepts and process optimisation of the manufacturing system

System integration

- Full or partial automation with linear axes for infeed and outfeed of parts
- Robot automation for handling components
- Completely integrated solution in the specific production workflow using state-of-the-art 3D process simulation
KUKA Industries supplies the machine perfectly tailored to your requirements

KUKA Industries can friction weld even the most difficult customer components. Offering cost-effective and high process reliability solutions our machine designs allow the ability to be tailored to your requirements with special sizes and designs available on request.

<table>
<thead>
<tr>
<th>Linear Friction Welding System</th>
<th>LRS</th>
<th>LR20</th>
<th>LR50</th>
<th>LR100</th>
<th>LR200</th>
<th>LR300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Application</td>
<td>Desktop system for Research &amp; Development, Universities, Institutes and small component production</td>
<td>Shop floor system for Near Net Shape and Component production line environment</td>
<td>Factory installation for Standard Sized Components, Near Net Shapes &amp; Aerospace Blisks</td>
<td>Factory installation for Large Aerospace Blisks &amp; Structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axial Forge Load (Tons Force)</td>
<td>0.25 – 5</td>
<td>1 – 20</td>
<td>2.5 – 50</td>
<td>5 – 100</td>
<td>10 – 200</td>
<td>15 – 300</td>
</tr>
<tr>
<td>Welding Area</td>
<td>500 mm²</td>
<td>2,000 mm²</td>
<td>5,000 mm²</td>
<td>10,000 mm²</td>
<td>20,000 mm²</td>
<td>30,000 mm²</td>
</tr>
<tr>
<td>Forge Positioning Accuracy (±)</td>
<td>0.100 mm</td>
<td>0.100 mm</td>
<td>0.100 mm</td>
<td>0.200 mm</td>
<td>0.200 mm</td>
<td>0.200 mm</td>
</tr>
<tr>
<td>Forge Construction</td>
<td>Cantilever and Carriage</td>
<td>Tie Beam and Carriage</td>
<td>Forge Back Beam and Carriage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Design</td>
<td>Open</td>
<td>Shot Bolt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component Capacity</td>
<td>Assessment of customer requirement to select system and/or modification</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Oscillator Frequency</td>
<td>Up to 100 Hz (dependent upon component and tooling mass)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oscillator Amplitude (±)</td>
<td>0.25 – 5 mm</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Oscillator Positioning Accuracy (±)</td>
<td>0.100 mm</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Electrical Power</td>
<td>Country and customer specific</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Foundation</td>
<td>300 mm Reinforced Concrete Floor DIN 1045 B25</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Temperature Specification</td>
<td>40°C ± 10%</td>
<td></td>
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</tr>
<tr>
<td>System Footprint (LFW dimension only)</td>
<td>1,200 mm (W) × 300 mm (D) × 1,150 mm (H)</td>
<td>3,100 mm (W) × 1,400 mm (D) × 2,700 mm (H)</td>
<td>9,500 mm (W) × 4,200 mm (D) × 4,100 mm (H)</td>
<td>9,500 mm (W) × 3,400 mm (D) × 5,045 mm (H)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Revolutionary control technology and process monitoring made by KUKA

KUKA’s range of linear friction welding machines feature control systems that use industry-leading hardware and software complemented by custom-designed software which is specifically designed for controlling and monitoring the weld process.

Control technology
At the heart of the system is the weld controller, which provides sequence, process and motion control. It is a scalable solution capable of addressing machine I/O, performing control tasks and communicating via Ethernet IP protocol not only with devices fitted on the machine, but also other external equipment.

Process parameter control and monitoring
• Numerical parameter monitoring with graphical curve trace
• Graphical and tabular display of parameters in different views
• Component and product data management
• Language settings
• Process diagnosis

Industrie 4.0
Even higher productivity can be reached by complete integration of the friction welding machines in your production network. This will require open interfaces and an intelligent control. As a manufacturer of flexible, automated production systems, KUKA Industries has the experience and competence to develop and realise process-safe and economically successful turnkey solutions. With their optimally accessible work space and the network capability of their control, the machines offer ideal conditions for the new age of Industry 4.0.
Long before the first workpiece passes through your application, we support you with our know-how.

Consultation, planning, engineering, implementation all the way through to complete customer service – all around the globe. We know what you need and have the right solution ready for you. One of the ways we ensure this is through our unique KUKA TechCenter. Our engineers carry out feasibility investigations and test the practicability of innovative concepts. Besides trial welds and parameter optimization, complete validation of your process is carried out.

Of course, the best kind of service is the kind that you don’t need to waste any time because everything functions perfectly. KUKA Industries offers you exactly this kind of service – it doesn’t just start with maintenance and spare parts; it’s process and system training to comprehensive concepts for supplying and stocking spare & wearing parts, not forgetting maintenance, servicing, telediagnostics and hotline support.

We can also take care of the complete manufacturing operation for you – from process validation to prototype construction and small-batch production at our sites in Halesowen (UK).
Together with our affiliated companies, KUKA Robotics and KUKA Systems, we can be found locally all over the world:

- Argentina
- Australia
- Austria
- Belgium
- Brazil
- Canada
- Chile
- China
- Czech Republic
- Germany
- Hungary
- France
- Great Britain
- India
- Italy
- Japan
- Korea
- Malaysia
- Mexico
- New Zealand
- Norway
- Poland
- Portugal
- Russia
- Sweden
- Switzerland
- Singapore
- Slovakia
- Spain
- South Africa
- Taiwan
- Thailand
- Turkey
- USA

For further information please contact us at frictionwelding.industries.de@kuka.com

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