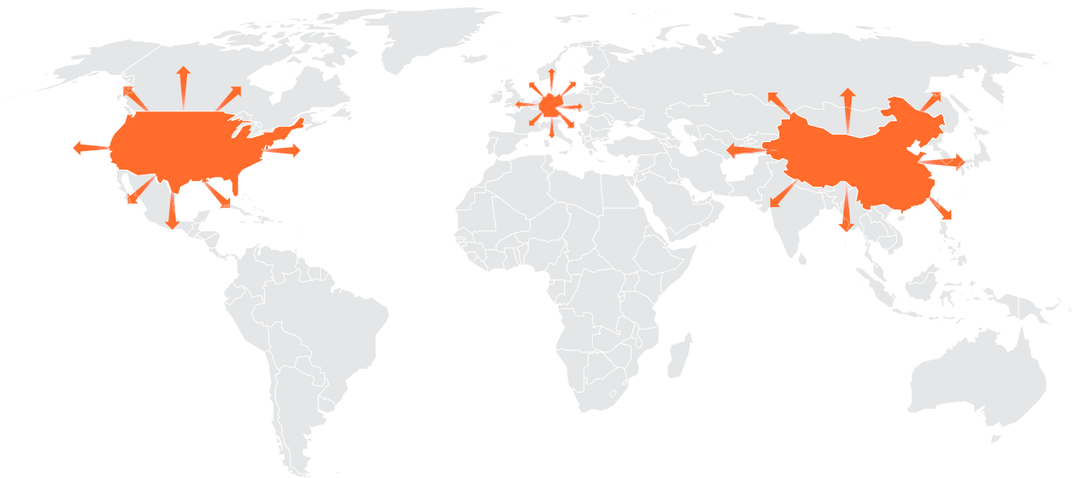
KUKA

Technology_**Friction stir welding**

EN

Find us locally

Our competent specialists cover the markets in EMEA, the Americas and Asia where we can provide testing facilities for validation of our solutions for your products.



Friction stir welding

Innovative technology for the growing e-mobility market

Individual solutions for challenging tasks

Friction stir welding from KUKA Industries is an integral part of KUKA's extensive spectrum of products and services. As a manufacturer of flexible systems for automated production, KUKA Industries has the experience and expertise to develop and implement cost-effective complete solutions with high process reliability. Our process and technology consulting is impartial and neutral with regard to selection of the suitable process, because only the result is important to us – the right solution for you.

Friction stir welding

The process is particularly suitable for the economical joining of non-ferrous metals and mixed-material combinations.

Friction stir welding (FSW) is a solid-phase joining process in which the materials to be joined are not melted to form a weld pool. The parts being joined are “stirred” by means of a rotating tool in the plastic state below the solidus. Friction stir welding is generally carried out using a tool consisting of a shoulder and a welding pin. The welding pin is positioned centrally under the shoulder.

The parts being joined are firmly clamped to the welding fixture. In the conventional process, the shoulder and pin rotate about their own axis and are pushed into the joint between the two workpieces with a defined force. Alternatively, there are processes with a fixed shoulder and a rotating pin. Frictional heat is generated between the tool and the parts to be joined, causing the material to plasticize.

Advantages of the process

Top weld quality

- No welding defects such as pores or cracks
- Joining of a wide variety of materials possible
- Comparatively low heat input since joining occurs at around 80 – 90 % of the melting temperatures
- High seam strength with minimal welding distortion

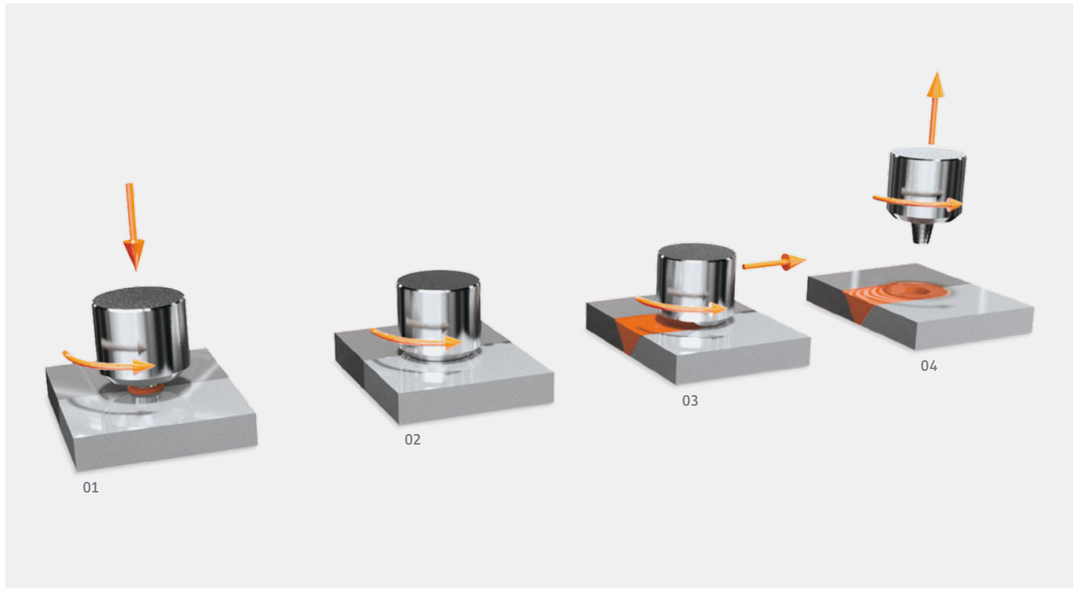
High savings potential

- Economical joining of complex 3D geometries
- Material savings through component optimization
- No consumables such as shielding gas or filler wire

Green technology

- Environmentally friendly process with low energy consumption
- No fume exposure or anti-glare measures required

Process steps



01 Approach and plunge
02 Dwell time for heating
03 Welding process with feed
04 Retraction at end of seam

Wide variety of material combinations

Possible weld forms

01 Butt joint
04 T joint

02 Lap joint
05 Corner joint

03 Combined butt and lap joint
06 Corner joint

The process is especially suited to welding aluminum alloys and other non-ferrous metals with low melting points.

	Steel, stainless steel and steel alloys	Titanium, titanium alloys	Magnesium alloys	Copper, copper alloys	EN AW-8000 (Al; other)	EN AW-7000 (Al; Zn; Mg; Cu)	EN AW-6000 (Al; Mg; Si)	EN AW/AC-5000 (Al; Mg)	EN AW/AC-4000 (Al; Si)	EN AW-3000 (Al; Mn)	EN AW-2000 (Al; Cu)	EN AW-1000 (Al, unalloyed)
EN AW-1000 (Al, unalloyed)	⊙	✓	✓	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
EN AW-2000 (Al; Cu)	⊙	✓	✓	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	
EN AW-3000 (Al; Mn)	⊙	✓	✓	⊙	⊙	⊙	⊙	⊙	⊙	⊙		
EN AW/AC-4000 (Al; Si)	⊙	✓	✓	⊙	⊙	⊙	⊙	⊙	⊙			
EN AW/AC-5000 (Al; Mg)	⊙	✓	✓	⊙	⊙	⊙	⊙	⊙				
EN AW-6000 (Al; Mg; Si)	⊙	✓	✓	⊙	⊙	⊙	⊙					
EN AW-7000 (Al; Zn; Mg; Cu)	⊙	✓	✓	⊙	⊙	⊙						
EN AW-8000 (Al; other)	⊙	✓	✓	⊙	⊙							
Copper, copper alloys	✓		✓	⊙								
Magnesium alloys			⊙						⊙			
Titanium, titanium alloys		✓							✓			
Steel, stainless steel and steel alloys	✓											

⊙ Weldability confirmed (for specific geom. dimensions)
✓ Weldability possible
Weldability unconfirmed

Extensive applications

Friction stir welding technology is used in many different industries, ranging from the automotive and aerospace industries to rail vehicle and ship construction and also the electronics sector and general industry.

Typical applications

Rail vehicle construction

- Joining of side walls and roof assemblies for high-speed trains
- Aluminum sheets or profiles (double-walled panels)
- Typical materials: 6000 series aluminum alloys
- Advantages:
  - Use of highly cost-effective FSW gantry systems
  - Integration of additional machining processes such as milling and drilling

Automotive industry

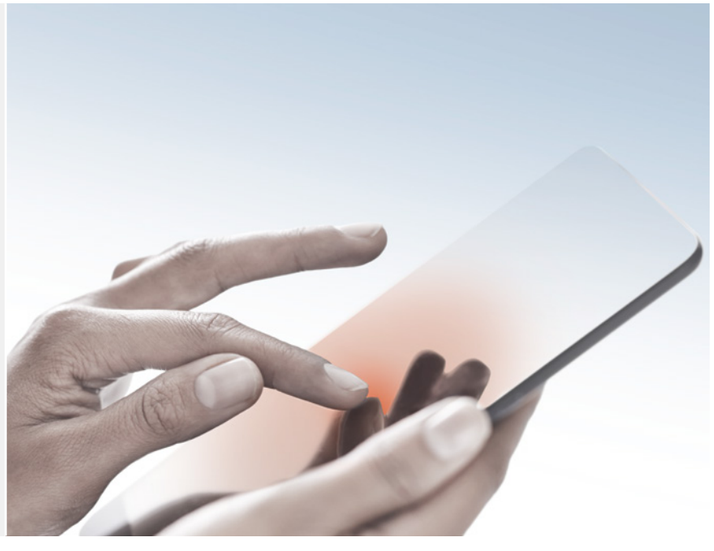
- Joining of automotive components for the cooling system, car body and powertrain as well as components for e-mobility
- Material combinations of aluminum sheets, continuously cast sections and cast components
- Typical materials: 4000 / 5000 / 6000 series aluminum alloys
- Advantages:
  - Economical joining of complex 3D seams
  - Joining of material combinations that are difficult to weld

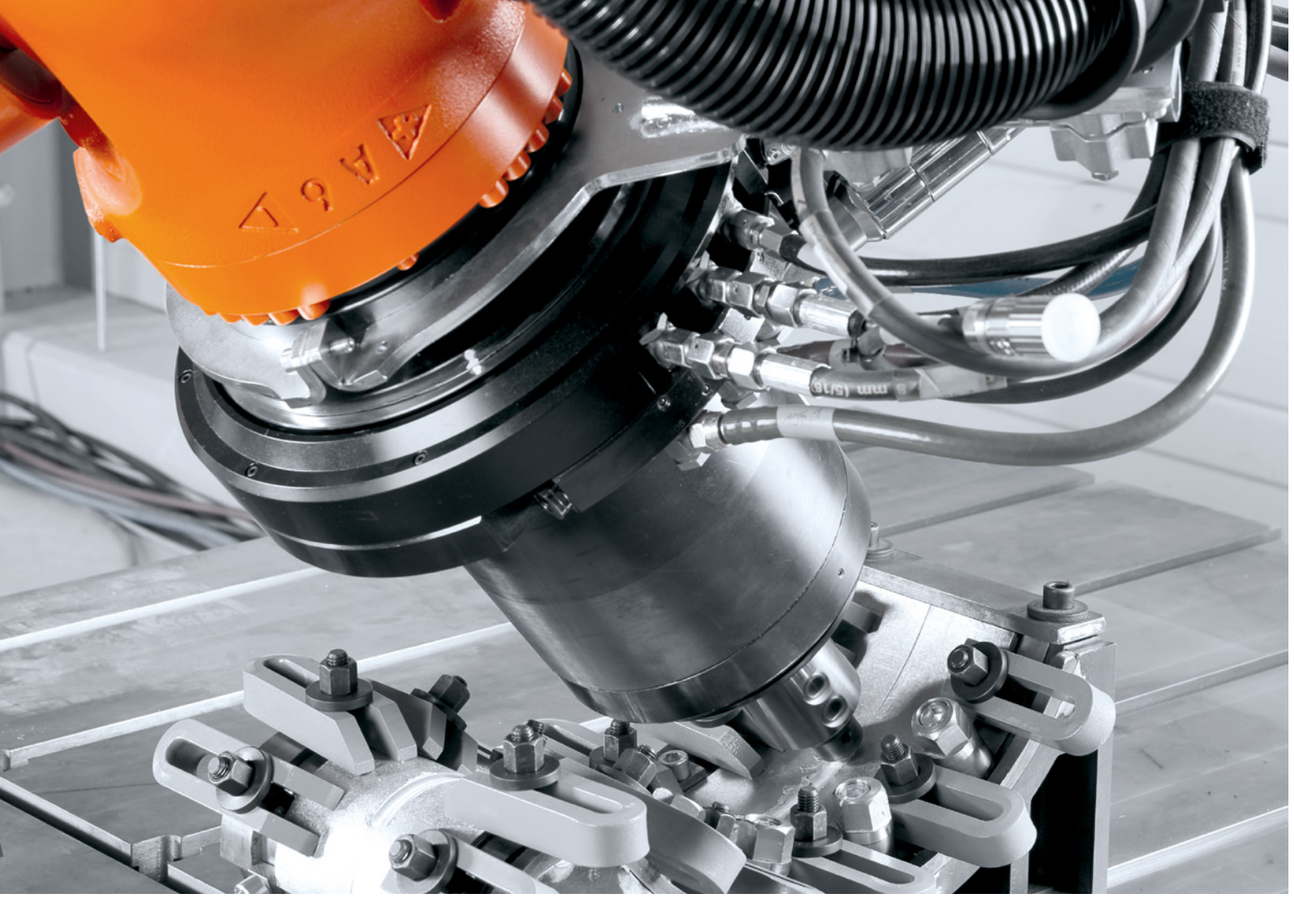
Aerospace industry

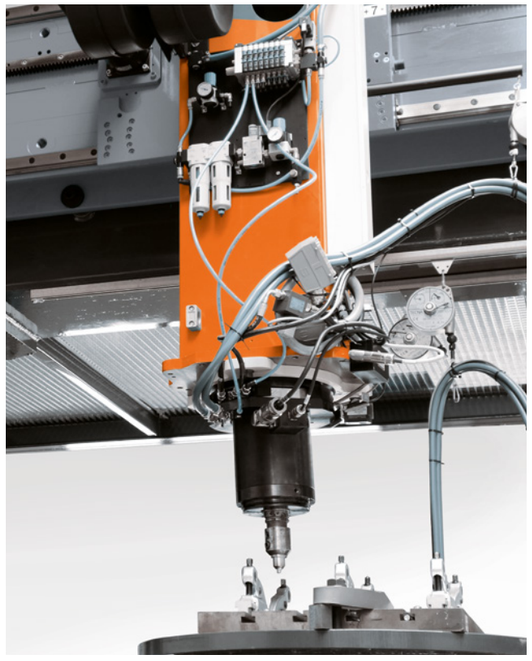
- Joining of aircraft fuselage parts and rocket components
- Typical materials: High-strength 2000 and 7000 series aluminum alloys
- Advantages:
  - Highly reliable and gas-tight weld seams
  - Low heat distortion and special surface characteristics

General industry

- Joining of cooling systems for power electronics and of housings for cell phones or control panels
- Cast components with aluminum sheets or sections
- Welds with high conductivity for transformers and batteries
- Typical materials: Aluminum, copper and magnesium alloys
- Advantages:
  - Economical joining of complex 3D seams
  - Joining of various material combinations







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 friction stir welding processes in automated manufacturing lines
→ Quality concepts and process optimization of the manufacturing system

Customized solutions
KUKA Industries offers you customized complete solutions that are cost-effective and have high process reliability. Besides robot-based solutions, we also offer solutions with gantries which can be perfectly adapted to suit your needs.

For applications in which a fixed shoulder is advantageous for welding, we offer you a solution incorporating ESAB-licensed technology.

Friction stir welding robot-based

Features

- Use of heavy-duty robots with process-specific software and hardware additions and expansions
- Suitable for the cost-effective joining of thin-walled non-ferrous metals (aluminum up to 8 mm)

Advantages

- Joining of complex 3D seams
- Large workspace, can be expanded by means of linear axes
- Low investment costs

Friction stir welding with gantry systems

Features

- Use of gantry systems with process-specific software and hardware additions and expansions
- Suitable for the cost-effective joining of large two-dimensional and thick-walled components made of non-ferrous metals

Advantages

- No limitation in the workspace
- Good accessibility
- Scalable stiffness

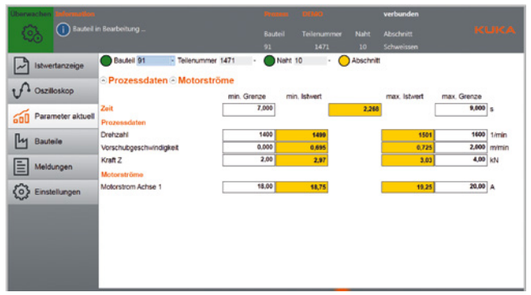
Revolutionary control technology and process monitoring made by KUKA

Control technology

- Force / torque control to compensate for component tolerances and compliance: Force control in Z direction and position control in X and Y directions
- Suitable for process forces of up to 10 kN in the entire workspace
- Uniform workspace for robots and positioners for simplified programming (mathematically coupled workspace)
- One controller for up to 18 axes (KRC4 Extended)
- Internet-based KUKA RemoteService

KUKA PCD: process parameter control and monitoring

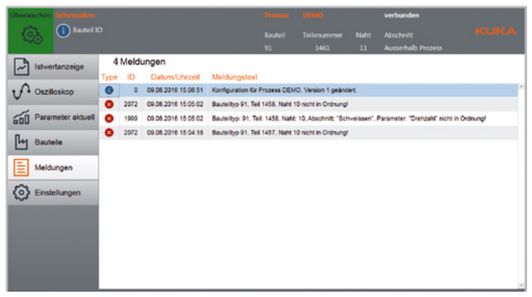
- Numerical parameter monitoring with graphical curve trace
- Graphical and tabular display of parameters in different views
- Component and product data management
- Language settings
- Process diagnosis



Numerical parameter monitoring

Graphical curve trace

Current process data



Diagnostic messages

Industrie 4.0

All process data from the KUKA PCD (Process Control and Documentation) are numerically monitored and electronically archived. These data are thus available for further analysis (for example, in Cloud systems). This is the basis for the implementation of Industrie 4.0. It increases productivity while ensuring traceable quality and data transparency.

KUKA Industries – Your global partner from engineering to service

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 you don't need to waste any words about because everything functions perfectly. KUKA Industries offers you exactly this kind of service – and it doesn't just start with maintenance and end with spare parts: from process and system training to comprehensive concepts for supplying and stocking spare and wearing parts, not forgetting maintenance, servicing, telediagnostics and hotline support.

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

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