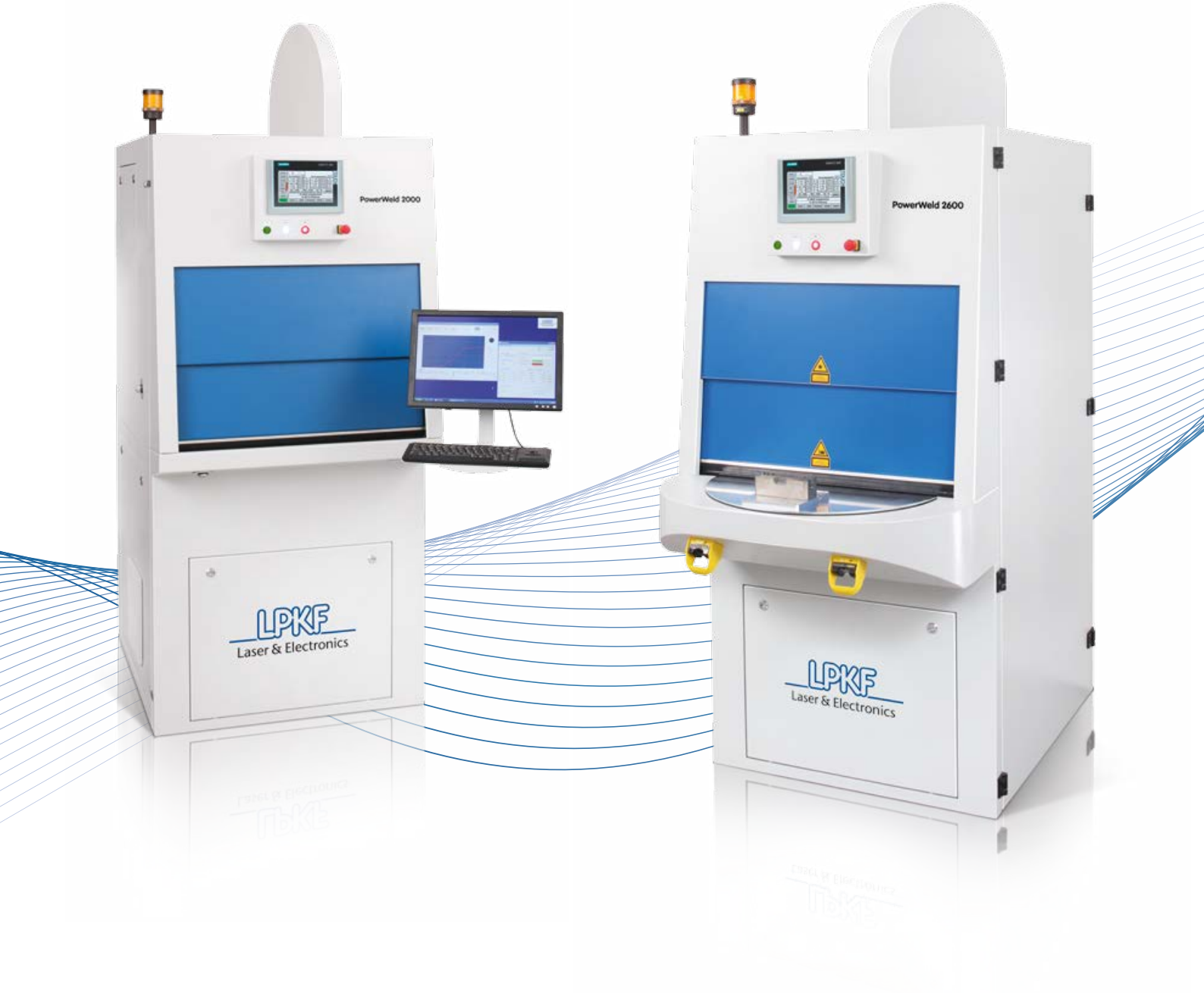
Economical Production with Top Quality

Plastic Welding with LPKF PowerWeld 2000 Systems



LPKF
Laser & Electronics

Precise welds for
microfluidic components

Growing with the Responsibilities ...

Laser plastic welding excels at creating highly precise weld seams following any contours, without harming the surrounding material. This technology is establishing itself in more and more areas of application: from automotive and medical technology, to electronics and consumer goods. The systems in the LPKF PowerWeld 2000 product line – represented by the PowerWeld 2000 and the PowerWeld 2600 – can be used universally thanks to the flexible laser technology.

Built-in Productivity

The LPKF PowerWeld 2000 has a range of systems to satisfy different customer specifications. Whilst the PowerWeld 2000 is specially designed for manual placement, the PowerWeld 2600 boasts a rotary table to reduce downtimes. Optimal workpiece quality and productivity are ensured by the reliable and proven system architecture, combined with efficient, high-performance controls and process monitoring. Both systems can be equipped with different types of laser sources.

More than just Systems

LPKF boasts a great deal of experience in laser welding. A specialized Application Center assists interested clients with their product layouts, process designs, and with job-shop production during production peaks for instance.

Clients benefit from an enormous amount of expertise – integrated within efficient, high-performance software specially developed for plastic welding.

- Productive, economical and flexible
- Secure welding results
- Integrated quality control

Possible Applications

Rugged RFID transponder with integrated sensor system

Valve unit for car-making applications

Secure joining of consumer products

Safety for Product and Production

The LPKF PowerWeld 2000 laser systems satisfy a range of different criteria for plastic welding. High-quality components within a compact housing maximize machine availability, whilst integrated online process monitoring assure product quality. The systems require no additional cooling, are CE safety certified, and use Class IV safety components.

The systems are operated intuitively via a touch-panel. Siemens PLC components ensure problem-free series operation. The ProSeT software comes as standard for the rapid setup of welding contours, and a pilot laser visualizes the weld contours.

Process Optimization and Tool Production

More than just machines: The LPKF Application Center provides assistance for process layouts and tool production – to shorten time-to-market, and optimize production throughput. LPKF supplies welding systems upon request with pre-set processes, or jointly optimizes them on site for perfect integration in the production setup.

Optimized Throughputs

A specially developed clamping module ensures reproducible welding positions, and the ergonomic loading and unloading of the subassemblies. The LPKF PowerWeld 2600 has a rotary table to reduce downtimes: fill one tray, weld one tray: whilst components are positioned outside of the welding cabinet, production continues inside the machine.

Monitored Quality

Even the basic model is equipped with the means to communicate with an MES. A melt-travel monitoring system verifies successful welding on the basis of a time-travel diagram. In addition, the transmission properties of the upper joining partner can be tested by the LPKF TMG 3 transmission tester.

Greater Productivity and Speed

24/7 in an industrial environment – no problem for LPKF's tried and tested laser welding technology. Well trained service staff are available around the world for commissioning and customer care services, not to mention an Application Center to help prepare feasibility studies and machine concepts, job-shop production to tackle production peaks, or ramp up of batch production. More than just laser welding. LPKF creates solutions – together with its clients.

Technical Data: LPKF PowerWeld 2000 / 2600

Laser class	1
Laser beam source / laser power	120 W, 250 W
Laser wavelength	980 nm
Processing field	150 mm x 110 mm (5.3" x 4.3")
Power supply	400 V – 3 phases/N/PE, 16 A, max. 3 kW
Air supply	Min. 4.5 bar, max. 10 bar
Ambient conditions	Max. operating temperature: up to 35 °C (95 °F) Max. humidity: up to 80% at 25 °C (77 °F)
Cooling system	At 120 W external water cooler, at 250 W internal air cooler
Configuration	Remote maintenance Automatic clamping tension control unit Process data capture and analysis (collapse distance) Coding (tool coding) Traceability data via fieldbus interface Optional: Data acquisition computer including additional software ProSeT
Main dimensions (W x H x D)	840 mm x 2200 mm x 1000 mm (33" x 87" x 39"); at PowerWeld 2600: 840 mm x 2200 mm x 1300 mm (33" x 87" x 51")
Weight	500 kg (1102 pounds)

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LPKF AG, 10005663-170217-EN

Hybrid Welding of Large, Complex Parts

Laser Plastic Welding with LPKF TwinWeld 3D

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Quality and Productivity

Wish list: better seams, higher flexibility and lower costs. The LPKF TwinWeld3D plastic welding system has all this and more: perfect welding of large components and low unit costs. The innovative laser hybrid welding system has revolutionized the volume production of tail lights in the automotive sector.

One Laser System, many Advantages

The secret of welding plastic with a laser beam lies in the precise control of the beam energy. LPKF does this in a new way: with the LPKF hybrid welding system, the welding process takes place in a thermal field. This produces optically and mechanically enhanced welding seams, higher processing speed, and new options for designers and engineers.

Now in its second generation, the LPKF TwinWeld3D joining system superbly demonstrates its capacity for the industrial production of large components – with high machine availability. The use of laser safety glass in the housing window gives the system a laser class 1 rating.

Cost-oriented Production

LPKF hybrid welding improves budgets even before a single part has been produced: the costs for welding tools drops considerably compared to other methods. A tensioning roller applies the necessary joining pressure. The project-specific costs sink to the production of a simple workpiece holder.

Production costs are also reduced: the annealing process, previously essential when manufacturing stress-crack-sensitive components such as car tail lights, is now completely unnecessary. All this means: lower unit costs, and economical production of even small numbers of pieces.

LPKF TwinWeld 3D 6000

As much Pressure as Necessary

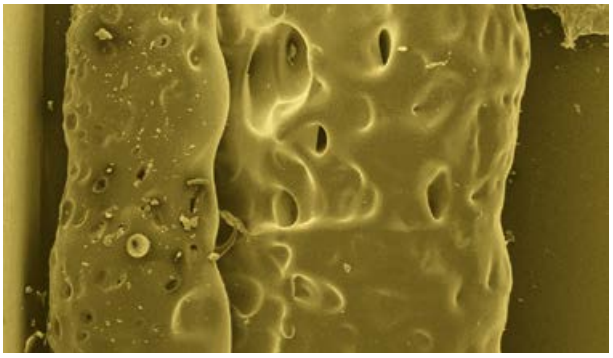
A defined clamping pressure is always required in the laser plastic welding process. This is provided by the hybrid welding head, so that expensive upper dies are no longer required.

The integrated air-sprung joining roller applies a constant vertical clamping pressure to the parts being joined. This roller runs over the component parallel to the welding process. The tensioner is cooled and uncoupled from the rotary movement of the welding equipment – to guarantee perfect product surfaces.

- Low-maintenance welding head
- Smaller space requirements
- No clamping tools needed

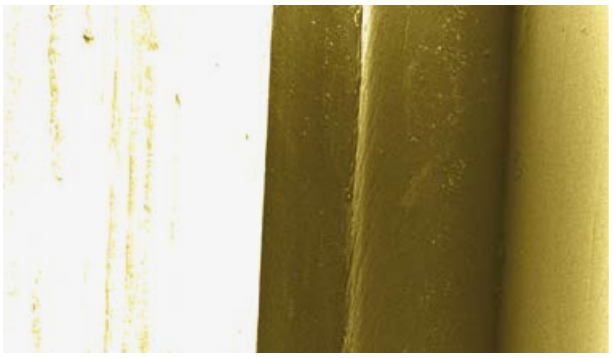
LPKF Hybrid Welding versus Hot Plate Welding

LPKF hybrid welding wins every time with a compact joint (50 x magnification).

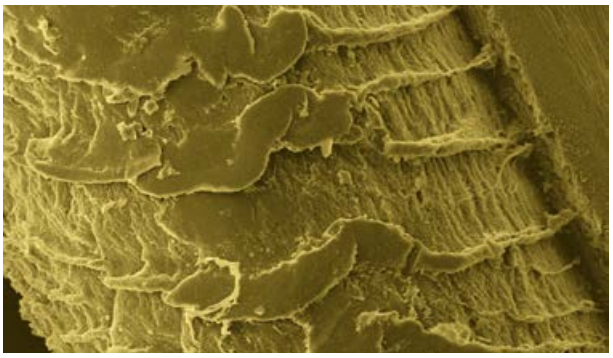


Massive melt blow-out and inhomogeneous structures during hot plate welding (50 x magnification).

LPKF Hybrid Welding versus Vibration Welding



A perfect welding seam produced by LPKF hybrid welding (150 x magnification).

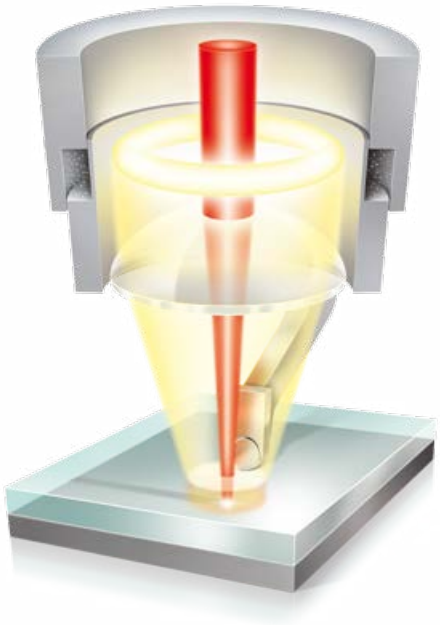


Vibration welding produces a scaly structure with the formation of particles at the margins (150 x magnification).

Intelligent Combination

In the laser plastic welding process, the laser beam passes through the laser-transparent joining partner and melts the surface of the underlying laser-absorbing part. Thermal conduction then melts the adjoining surface of the upper part, and a defined clamping pressure creates a strong reliable joint.

In the patented LPKF hybrid welding technique, special halogen lamps apply extra energy to the welding zone through polychromatic radiation. This halogen/laser combination increases the processing speed and creates superb looking welding seams. It also reduces the internal stresses. LPKF hybrid welding can therefore do what other welding methods fail to do: produce reliable, perfect, and almost stressless welding seams without any additional treatment.



- High quality seams in visible locations
- Particle-free welding
- Flexible contour guidance
- Lower unit costs

Ultramodern light-guiding technology – welded by the LPKF TwinWeld3D 6000

Brilliant Insights

LPKF hybrid welding has already impressively demonstrated its class in the industrial production of car tail lights. The LPKF TwinWeld3D is also very interesting for the production of other components which require top quality welding seams. By using a special PP blend, it is also possible to weld car headlights with the classic polycarbonate – polypropylene material combination.

New Technological Dimension

Something very special was required: the Hyundai Equus – the flagship model of the Korean carmaker – sets itself apart from its competitors with its light design. In a joint project with LPKF, SL Corp. in Deagu, South Korea, developed a tail light which produces spectacular effects with ultramodern light-guiding technology. The function groups are working together closely to create a three-dimensional effect. This is beyond the realms of conventional welding methods. The LPKF TwinWeld3D can place the welding seams in the visible area – seams so perfect that they are an integral part of the design concept. The welding seams boast levels of brilliance and precision unmatched by any other method.

"Thanks to the LPKF hybrid welding technique, SL Corp. has not only produced welding seams with previously unheard of quality, it also dramatically reduced the reject rate."

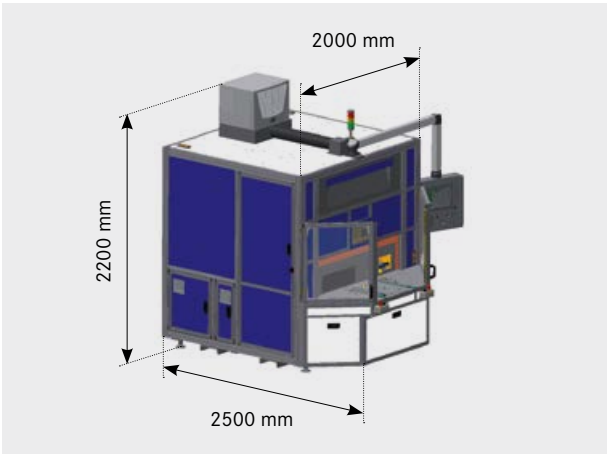
Simyun Sung, Manager SL Corp.

Worldwide Service & Support

24/7 in an industrial environment – no problem for LPKF's successfully tried and tested laser welding systems. For your support we have: highly trained service staff around the world available for commissioning and servicing; an Application Center to help with feasibility studies and machine concepts; job-shop production to tackle production peaks and volume production start-ups. More than just laser welding: LPKF creates solutions – together with its clients.

Technical Data: LPKF TwinWeld 3D 6000

Laser class	1
Beam source	100 W
Laser wavelength	980 nm
Working area	750 mm x 500 mm (29" x 20"), other options available
Power supply	400 V – 3 Phase/N/PE, 16 A, max. 4 kW
Compressed air	6 bar
Ambient conditions	Max. ambient temperature: 35 °C (95 °F); max. air humidity: 80 % at 25 °C (77 °F)
Cooling	Integrated air recooler
Options	Rotary table, Proportional pressure control valve, Remote servicing
Main dimensions (W x H x D)	2000 mm x 2200 mm x 2500 mm* (79" x 87" x 98")*
Weight	3000 kg (6614 pounds)



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LPKF AG, 10005437-051017-EN

Economical & Reliable Joining of Cylindrical Parts

Laser Plastic Welding with LPKF InlineWeld 2000

- Integral laser plastic welding solution for cylindrical and non-rotatable workpieces
- Increased power for high production throughput
- Robust and well-established process technology
- Integrated quality assurance system
- Little required installation space and extensive interfacing options
- Cost-efficient in investment and maintenance

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Optimized Radial Joining of Cylindrical Parts

Radial welding of rotationally symmetric plastic parts has never been easier than with the new LPKF InlineWeld 2000. Developed for automated production lines, the system consists of a welding head with a powerful laser source and a rotary arm for fast welding processes, which also allows, for example, the processing of elliptical cylinders. The architecture of the system is highly adaptable, allowing the customer a high degree of part design flexibility. The quality of the radial welding process is monitored and controlled by an integrated pyrometer.

Radial Welding

The InlineWeld 2000 system features a compact laser head equipped with an arm that quickly rotates around the workpiece, selectively directing the laser beam along the junction to be welded. The part itself remains in a fixed position during the welding process. If required, a clamping pressure can be applied by a pressure unit.

The resulting weld seams are strong and robust, whilst the surrounding material remains unaffected by the welding process. This leads to perfect joining results in terms of function, performance and optics – whether you need the application for components for the automotive industry, medical technology or any other industry sector.

Widely Applicable

The system has been specifically designed to meet the customer needs in terms of part dimensions and design. Thanks to a ground-breaking alignment concept and easy exchangeability of components, a wide range of diameters and welding seams can be processed using the same system. This revolutionary alignment concept guarantees an unbeatable reproducibility and a high degree of standardization among welding systems, also allowing to quickly react if the process requirements change.

Process Monitoring

The welding process is optionally monitored by a pyrometer and regulated by a controller. This ensures a high production throughput and unrivaled part quality.

A Solution to Any Requirement

The InlineWeld 2000 is a fully functional welding system. It can either be integrated into an automated production line or be operated as stand-alone system in production or laboratory environments.

LPKF InlineWeld 2000	
Laser class	1 (after integration)
Laser parameters	200 W, spot: 1 mm – 5 mm
Part diameter	5 mm – 80 mm
Welding head dimensions (W x D x H)	331 mm x 370 mm x 1043 mm
Control cabinet dimensions (W x D x H)	800 mm x 500 mm x 1300 mm
Options	Pyrometer, controller, interface box, pressure unit

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LPKF AG, 040221-EN

Laser Plastic Welding in Production Lines

Compact and Economical: LPKF InlineWeld 6200

- Welding head for direct integration in the production line
- ProfiNet interface for industry 4.0 integration
- Boosted laser power
- Cost efficient investment
- Laser class 1 after integration

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Powerful, Efficient, Compact

LPKF laser welding systems in the InlineWeld series are already working successfully in many production lines worldwide. The LPKF InlineWeld 6200 is the first of a new price-performance class for integration systems. Laser plastic welding will thus become attractive for even more applications.

The flexible modules of the LPKF InlineWeld series enable laser plastic welding to be directly and easily integrated into the production lines of a wide spectrum of business sectors: The modules only need a small amount of space for the laser head, and all of the functions relevant for the process are included in the integration systems. The technical embedding uses standard electrical and mechanical interfaces.

The new generation of integration systems boasts a new machine layout – and not just on the outside. Costs are reduced and system performance boosted, thanks to a clever combination of the most up-to-date components.

The welding field measures up to 100 mm x 100 mm. The system conforms to the laser protection stipulations, and corresponds to laser class 1 during production operations. In addition, the clamping technology, the cylinder unit and the component holder are all equipped with safety sensors. This makes it really easy to realize installation in production lines in conformity with EN-ISO 11553.

Powerful laser systems need powerful software. The InlineWeld 6200 is supplied with the LPKF CAM software ProSeT – to set up the welding contour quickly and easily.

A ProfiNet interface enables the connection to the client's own manufacturing execution system (MES). The InlineWeld 6200 accepts the process data, and in turn supplies the values for the actual welding process – such as the time/melt travel data for quality assurance. The complete process control and monitoring is comfortably handled by the client's higher-level, central control system. The separately available LPKF Interface Box can decentrally set up process data and system parameters without connection to the MES, and operate the InlineWeld 6200 as a standalone after mounting in a production cell.

With the relevant line integration and control, the InlineWeld 6200 is also an efficient solution for production with a high level of variance and fast cycles.

LPKF InlineWeld 6200	
Laser class	1 (after integration)
Laser power/spot diameter	Max. 200 W / 1.8 mm or 2.1 mm
Clamping pressure range	580 N – 1750 N
Max. working area	100 mm x 100 mm
Welding head dimensions (W x D x H)	400 mm x 450 mm x 1300 mm
Control cabinet dimensions (W x D x H)	950 mm x 600 mm x 1350 mm
Power supply	400 V, 16 A, max. 3 kW
Compressed air	4.5 bar – 10 bar
Ambient temperature	18 °C – 35 °C
Options	Remote Maintenance Module, Interface Box

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LPKF AG, 10068433-101016-EN

Laser Plastic Welding at the Highest Technological Level

Integrated and Efficient: LPKF InlineWeld 6600

- Powerful laser plastic welding system for integration in production lines with and without MES
- Exceptionally short cycle times and minimized production costs
- Easy process setup due to state-of-the-art software and optics
- Integrated quality assurance and extensive interfacing options

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Efficient Production of High Volumes

The new LPKF InlineWeld 6600 sets benchmarks for the joining of plastic parts in fully automated manufacturing environments. The user-friendly software enables unrivaled efficient process setup. High-end functionalities as well as integrated process and quality control ensure the highest welding quality and optimum machine utilization.

The powerful LPKF InlineWeld 6600 laser system is designed for three-shift operation. It is space-saving and can be easily integrated into production lines thanks to standardized electrical and mechanical interfaces.

Simple Process Equipment – Economical Application

The perfect interaction of hardware and software makes a major contribution to the economical use of the machine. After just a few mouse clicks, the software generates a contour that is converted into a perfect welding result on the calibrated working field. By simple copying of parameters and contours the setup can be transferred to other calibrated LPKF machines without any need of machine-specific adaption – for a reliable and comparable quality of your products worldwide.

Efficiency in the Production Process

Thanks to the variable servo clamping technology and the homogeneous power distribution of the specially developed LPKF laser, the new generation of the InlineWeld 6600 achieves significantly shorter cycle times than standard systems. The optional use of double clamping technology further reduces production times. The high-precision clamping force control and the specially developed beam profile ensure a consistently high joining quality over the entire weld seam. The large, variably usable working field ensures flexibility regarding component sizes.

In addition, the machine with its adjustable laser spot and variable working levels is flexible and quickly applicable for the production of different components in one line.

Focus on Process Reliability

Integrated process monitoring ensures maximum process reliability. The time/joining path data are evaluated for each weld in the course of increased quality assurance. Temperature monitoring, directly at the melting point, will be available soon for a further significant improvement in process monitoring and quality assurance.

Ideal for MES Operation

The InlineWeld 6600 features a compact laser head with a separate control cabinet. The welding system for integration can be easily connected to an existing Manufacturing Execution System (MES).

LPKF InlineWeld 6600

Laser parameters	380 W, laser class 1
Maximum part size (X/Y)	Single clamping: 250 mm x 110 mm; double clamping (2x): 110 mm x 110 mm
Focused spot size	2,2 mm – 4 mm (freely adjustable)
Clamping force	Max. 4 kN (single clamping); max. 2,5 kN (double clamping)
Clamping unit	Servo-clamping top down
Welding system dimension (WxDxH), Weight	600 mm x 829 mm x 1773 mm (excl. cabinet), 450 kg (excl. cabinet)
Compressed air	4,5 bar – 10 bar (dry and clean compressed air); only necessary when tool cooling is required
Ambient temperature	18 °C – 35 °C (under non-condensing conditions)

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LPKF AG, 10089907-300919-EN

Integration Systems for Laser Plastic Welding

LPKF InlineWeld Systems

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Precision, Security, Economy ...

Laser plastic welding is opening up new markets; laser systems and welding techniques are becoming ever more economic, so that more and more applications are benefitting from the precision and quality of laser technologies. The systems making up the LPKF InlineWeld family allow laser plastic welding to be integrated seamlessly in client production processes.

Optimum Joining Processes

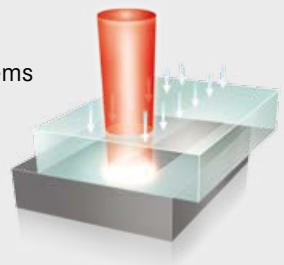
The market for joining plastic components with laser light is growing fast because laser systems are now highly persuasive, maintenance-friendly and do not require skilled operators. LPKF goes the extra mile working with customers to design customized workpiece carriers and to develop optimized welding processes.

The InlineWeld family contains systems which can be directly integrated into existing client installations. Appropriate tool configuration allows categorization as laser class 1.

Transmission Laser Welding

Transmission laser welding involves the laser beam penetrating the upper laser-transparent component and heating the lower laser-energy absorbent component along the weld. The transmitted heat plus moderate pressure on the joint causes the upper component to join to the lower. After cooling, the result is a robust welded seam satisfying the highest visual quality requirements.

LPKF laser welding systems for plastic use quasi-simultaneous, radial and contour welding techniques.



LPKF Laser Plastic Welding:

- High welding quality
- Low mechanical stressing of components
- Fast variation change
- Short cycle times
- Integrated interfaces allow full traceability

Flexible and Economic

Laser plastic welding is now firmly established as a high quality welding technology in the automotive, medical and electronic industries. The advantages are easy to see.

The integratable LPKF laser welding systems guide the laser beam on to the component using scanner optics. Adjustments to the control data allow lightning fast and straightforward adaptation of the welding contour. The equipment package software stores all parameters after each single process.

Water-tight welded seams for a pool lighting system

Laser welding is also a near stress-free process, with no mechanical vibrations or high temperature input as you may see from other welding methods. A component is generally only subject to that clamping pressure needed to hold it firmly in place, usually 4 to 6 N per mm^2 weld seam area. Clamping tool conversion is a matter of minutes.

Transmission laser welding also benefits from short cycle times. Depending upon customer handling requirements, this helps cut down-times. LPKF laser systems are designed for 24/7 operations, are basically maintenance-free and are ready for full tracking & tracing depending upon interface.

Test and correction routines take place during the actual welding process. This approach allows changed material parameters or geometric deviations to be determined quickly and in most cases compensated for during the welding process.

Lean Joining SOLUTION

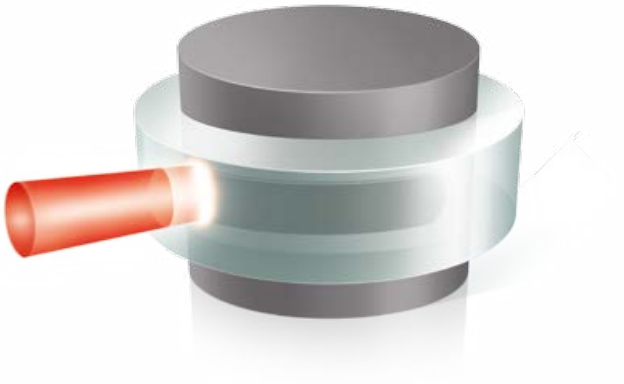
Lean Joining Solution

Low cost, low space needs, short cycle times: LPKF InlineWeld systems can be integrated as black box units in customer environments, and simply do their job. There is no need for specialized laser technicians or complex protective measures in production areas.

Contents

LPKF InlineWeld 2000 –
An Integration System for Radial Welding

Radial welding has proven its capabilities in rotation-symmetrical welding operations. In radial welding, either the component is turned under the laser beam or the laser beam is dynamically guided around the component using mirrors (Fig. right). Radial welding has the advantage that it can usually do without any additional clamping tools in cases where the necessary pressure is provided by the design fit of the components – e. g. pipes.

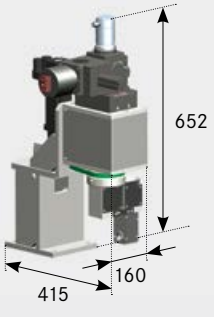


At radial welding the necessary pressure is provided by the design fit of the components – additional clamping tools are not necessary

Radial handling of the welded seam for the laser beam is possible with all LPKF welding systems, depending only on the component holding method. LPKF InlineWeld 2000 units take a different approach: a rotating mirror system guides the pre-focused laser beam around the component. This makes fitting and removing the component much easier.

LPKF InlineWeld 2000 comprises a processing head and a separate laser/control unit. The compact control unit can be located independently of the processing head and therefore takes up no space in the machining area.

The InlineWeld 2000 means LPKF has added a high performance system to its product portfolio, offering a laser welding system which is simple to integrate and designed specifically for radial welding.

Technical Data	InlineWeld 2000	Dimensions (mm)
Laser power	20 W to 500 W	
Clamping Force	Optional max. 1 kN	
Power supply	400 V / 16 A CEE	
Processing field	Standard: Diameter 0 mm (0”) to 80 mm (3”) Optional: Diameter 0 mm (0”) to 250 mm (10”)	
Dimensions (W x H x D)	With fixture: 415 mm x 652 mm x 160 mm (16” x 26” x 6”)	

Reduced Production Space Requirement – LPKF InlineWeld 6200 and 6600

A unique design feature shared by both the InlineWeld 6200 and 6600 systems are the separate housings for the control electronics and the low maintenance laser source. The link with the compact laser head is electronic. Each laser head contains the high precision laser optics and clamping technology. The separate integration systems in combination with the right tools are categorized as laser class 1.

LPKF InlineWeld 6200

The latest arrival in the InlineWeld family is the LPKF InlineWeld 6200. The new generation of integration systems boasts a new machine layout – and not just on the outside. Costs are reduced and system performance boosted, thanks to a clever combination of the most up-to-date components.

The welding field measures up to 100 mm x 100 mm. The system conforms to the laser protection stipulations, and corresponds to laser class 1 during production operations. In addition, the clamping technology, the cylinder unit and the component holder are all equipped with safety sensors. This makes it really easy to realize installation in production lines in conformity with EN-ISO 11553.

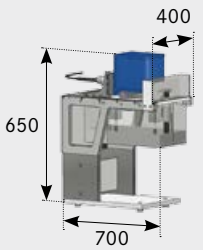
The InlineWeld 6200 is supplied with the LPKF CAM software ProSeT – to set up the welding contour quickly and easily. A ProfiNet interface enables the connection to the client's own manufacturing execution system (MES). The system comes with integrated melt travel monitoring and time-route control. Other monitoring technologies include pyrometer surveillance, burn detection and reflection diagnosis.

Technical Data	InlineWeld 6200
Laser class	1 (after integration)
Laser power/spot diameter	Max. 200 W / 1.8 mm or 2.1 mm
Clamping pressure range	580 N – 1750 N
Max. working area	100 mm x 100 mm
Welding head dimensions (W x D x H)	400 mm x 450 mm x 1300 mm
Control cabinet dimensions (W x D x H)	950 mm x 600 mm x 1350 mm
Power supply	400 V, 16 A, max. 3 kW
Compressed air	4.5 bar – 10 bar
Ambient temperature	18 °C – 35 °C
Options	Remote Maintenance Module, Interface Box

LPKF InlineWeld 6600

The LPKF InlineWeld 6600 integration system can weld both contours as well as more complex scanner-based components with sizes of up to 215 x 215 mm. It is designed for tripleshift round-the-clock operations and high throughput. The laser output has a range of 50 W to 500 W.

The housing measures 800 x 2000 x 800 mm (W x H x D), the processing head takes up a space of 400 x 650 x 700 mm (W x H x D).

Technical Data	InlineWeld 6600	Dimensions (mm)
Laser power	50 W to 500 W	
Clamping Force	Min. 200 N, max. 2.2 kN	
Power supply	400 V/16 A, power consumption: max. 3 kW	
Processing field	Up to 234 mm x 317 mm (9.2” x 12.5”)	
Dimensions (W x H x D)	Welding unit: 400 mm x 650 mm x 700 mm (16” x 25.5” x 27.5”) Control housing: 800 mm x 2000 mm x 800 mm (31.5” x 79” x 31.5”)	

Applications for LPKF InlineWeld 6200 and 6600

Automotive, medical, consumer: Examples for laser plastic welding.

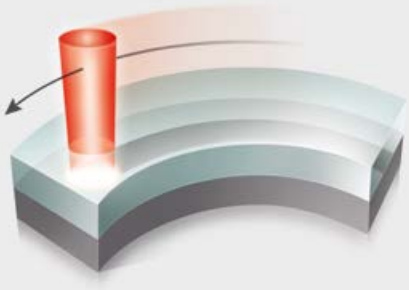
Break fluid reservoir

Monitoring device for blood bag

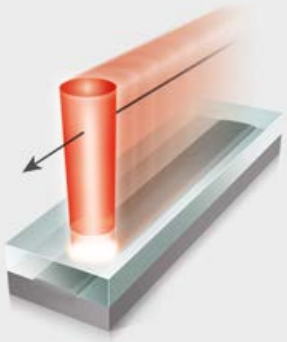
Razor casing

Established Processing Methods

At contour welding the laser beam is guided once along the joint line.



In the quasi-simultaneous welding method, the whole joint line is plasticized at the same time. The laser supplies energy continuously until the specified welding depth has been reached.



Material Qualification with LPKF TMG 3

The optical transmission of a plastic is crucial for the quality of the welded joint. This material property can be influenced by the upstream processes of compounding and injection molding. A quick and easy measuring of the optical transmission prior to laser plastic welding is an essential part of integrated quality assurance.

The calibrated measuring tool LPKF TMG 3 enables the transparency properties of plastics to be quickly and easily checked and proved. It only takes a few seconds to check that the actual transparency metrics match the set values in the process definition. Testing reveals any deviations in the materials before an unsuitable component enters the production process. The LPKF TMG 3 is calibrated with a measurement standard according to DIN EN ISO/IEC 17025 and is shipped with a works calibration certificate.

LPKF InlineWeld 6900

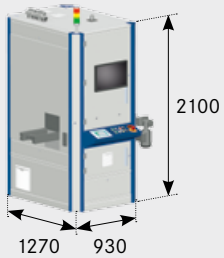
The LPKF InlineWeld 6900 laser welding system is comprised of standard modules from other LPKF series and creates an enclosed welding cell with conveyor belt system, laser source, welding head and control unit in standardized housings. No extra external enclosure is needed. This gives the system the benefit of a remarkably small footprint of only 930 x 1 270 mm.

On the design side, the system is ready for a wide range of client-specified conveyor belts. The modular housing concept also allows return lines for conveyor systems to be integrated, side-by-side or one above the other. The LPKF InlineWeld 6900 is a plug-and-play design and can be integrated into existing or new lines.

This unit is available for delivery with conveyor belt drives, control is then via either LPKF systems or customer in-house.

This unit's extraordinary flexibility is underpinned by continued process technology innovation: a novel bottom-up clamping module gives ultimate levels of process reliability and flexibility. In conjunction with an optional tool swapping system, this allows automatic welding of components of different heights. Together with a component identification unit, this system is suited to high variability coproduction processes because tooling change-over times are reduced to a minimum.

Technical Data	InlineWeld 6900	Dimensions (mm)
Laser power	50 W to 400 W	
Clamping Force	Min. 80 N, max. 3.5 kN	
Power supply	400 V/16 A, power consumption: max. 3 kW	
Processing field	Up to 133 mm x 238 mm (5.2" x 9.4")	
Dimensions (W x H x D)	930 mm x 2100 mm x 1270 mm (36.6" x 82.5" x 50")	



Examples of Applications

Automotive seating comfort electronics

Welded display of a process control unit for a forklift

Backlighted door sill of a premium class car

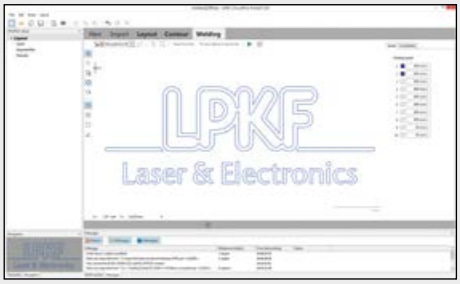
Lab-on-a chip: microfluidic cartridge in the size of a mobile

Topping for a bedside infusion management system

Sealed insulin pump for high-performance sportspersons

LPKF Software ProSeT

The tried and tested LPKF ProSeT control software is perfect for programming weld contours. The software uses data from CAD layout programs and enables adaptation and optimization of the welding contour. ProSeT is supplied with all LPKF laser welding systems as standard. The pilot laser helps adjust the welding contour to the component.



LPKF InlineWeld 9000

LPKF has been producing and selling systems for laser transmission welding since 2001. The LPKF InlineWeld 9000 is a modular system built upon the success of previous generations of LPKF laser welding systems. The modular design allows for easy customization of various optional components and features in order to meet the demands of each customer's specific needs in regards to laser power, clamping configuration, and handling methods – or even configured as a stand-alone, turn-key unit. These systems can also be precision-adjusted to customer specifications, e.g. with special sensors, footprints and handlings methods.

The InlineWeld 9000 series by LPKF already includes a large number of proven solutions. The unit illustrated above is fitted with two independent manual workstations fed via a continuous conveyor. The system is capable of performing up to six individual welding procedures on an assembly and replaces a highly complex adhesive solution with an annealing oven – delivering high performance in a compact unit with a small footprint.

Easy
WELDING

Easy Welding

Production data in, components out: this is the concept implemented in LPKF systems for laser plastic welding. For each and every product the welding parameters need to be determined just the once: they are memorized and can be reused again and again. The welding contour is configured based on design data taken from the CAD system while integrated QM functions offer unequivocal verification of welding success.

- Customer-specific solutions based on LPKF module catalogue/platform
- Up to 20 welding operations feasible in one single plant

Example of application:
Control device for electronic steering systems

LPKF Clamping Technology

The clamping technology needed for transmission laser welding can be kept relatively simple: the clamps do not need to transfer either vibrations or temperatures up to the melting point. A relatively low clamping pressure is sufficient for transferring heat between the upper and lower component. LPKF developed its patented dual clamp device to create even pressure on both sides of the weld line, a development which helps reduce dimensional tolerance still further.

Quick Connect

The upper and lower halves of the clamping tool can be installed quickly by one person. This is thanks to standardized adapters. Two minutes – and production is ready to roll with a different product group. The inexpensive clamping tools are much lighter than those needed for vibration processes. Some systems include a clamp coding system which identifies the mounted clamping tool automatically. The Quick-Connect system reduces unproductive downtimes and raises variability options in production planning.

Worldwide Service & Support

24/7 in an industrial environment – no problem for LPKF's successfully tried and tested laser welding systems. For your support we have: highly trained service staff around the world available for commissioning and servicing; an Application Center to help with feasibility studies and machine concepts; job-shop production to tackle production peaks and volume production start-ups. More than just laser welding: LPKF creates solutions – together with its clients.

Full Round-the-Clock Service

The clients of LPKF Laser & Electronics AG enjoy full round-the-clock service to guarantee optimum availability of their equipment. Service technicians or engineers are available for commissioning the LPKF welding systems and to ensure that production starts smoothly. When the welding systems are running, highly qualified service staff provide professional support via hotlines, remote diagnosis or on-site trouble shooting.

The global LPKF network for service and distribution:

- Headquarters
- LPKF Group
- LPKF Distributors

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Pictures may show optional accessories.

LPKF AG, 10033295-141016-EN

Revolution in Laser Plastic Welding

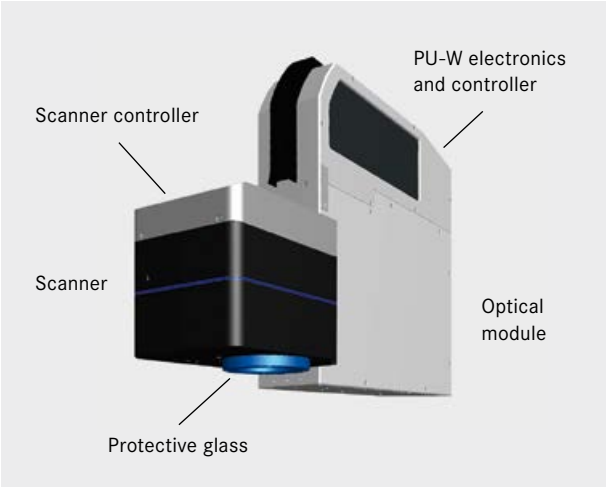
Processing Unit LPKF PU-W

- For the latest generation of laser welding machines
- For users with high demands on efficiency and flexibility
- For the future, today

LPKF
Laser & Electronics

The Heart of the Laser Welding Machine

Innovation is a tradition at LPKF – borne of a pioneering spirit and for the benefit of the customer. The laser technology specialists have now completely reworked the heart of the laser welding machine. The result is impressive. Using the newly developed Process Unit Welding (PU-W) process, the systems are now more flexible, powerful, and precise than before. This represents a major step for the next generation of laser welding systems, and for you: through this innovation, you have even more design freedom when planning your machinery.



Unique Optical Concept

The heart of the laser plastic welding machines is the processing unit. LPKF developed „Processing Unit Welding“ (PU-W) for its machines to help significantly improve the system performance. The entire optical line – from the software through the PU-W and the scanner controller to the scanner itself – has been specifically adapted to the requirements of laser plastic welding. What‘s so special about the new optical system?

High Flexibility:

- The laser spot size can be adjusted continuously from 2.2 mm to 4 mm
- The user-friendly next-generation software includes CAD import, easy contour adjustment, and many other features
- Uniform process chain: The optical system does not have to be converted for new tasks

Unmatched Precision:

- The fully digital scanner works extremely precisely with minimal drift
- Calibrated diameter of focused laser beam
- Calibration of the scan field provides for optimal transmission of welding contours, even between different systems

Perfect Fit for Your Production:

- Straightforward, fast setup of process parameters with simultaneous detection of shadow effects is made possible through coupling with a coaxial camera
- Infrared illumination makes the welding area visible even in the case of colored (e.g., IR-transparent black) overlays
- New possibilities for process monitoring via pyrometry
- The LPKF laser provides a larger process window for increased reliability thanks to the homogeneous top-hat radiation profile developed in-house
- Energy consumption and investment are lowered due to the improved energy distribution within the laser spot – the top-hat profile requires less power during welding
- Specific calibration allows for improved welding quality

The first systems in the LPKF InlineWeld 6600 series will be equipped with this processing unit in 2018. Contact us!

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LPKF Service & Support

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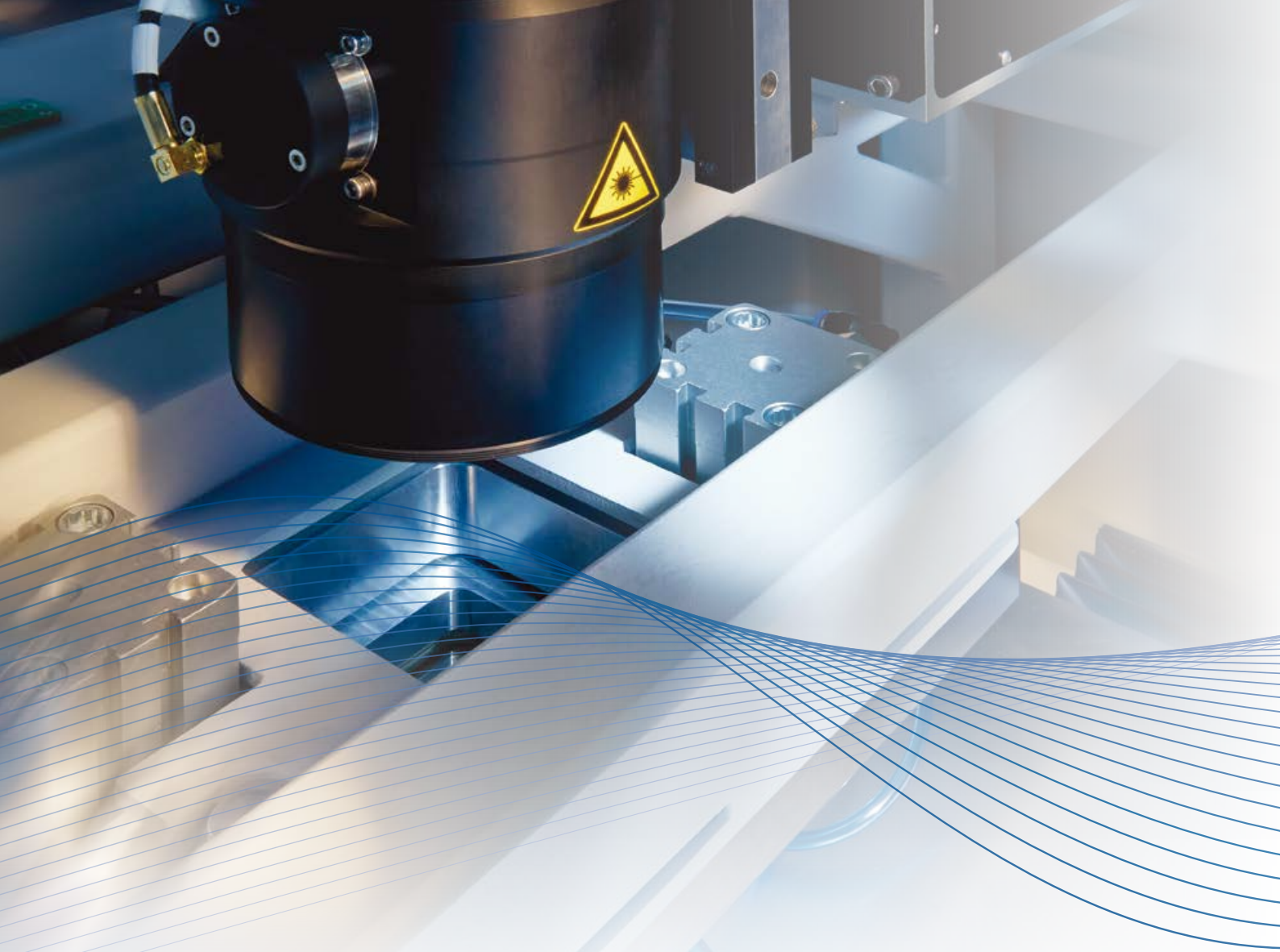
LPKF AG, 051017-EN

Microfluidics and Clear-Clear Joints

Precision Welding with the LPKF PrecisionWeld

LPKF
Laser & Electronics



A Major Breakthrough in Technology

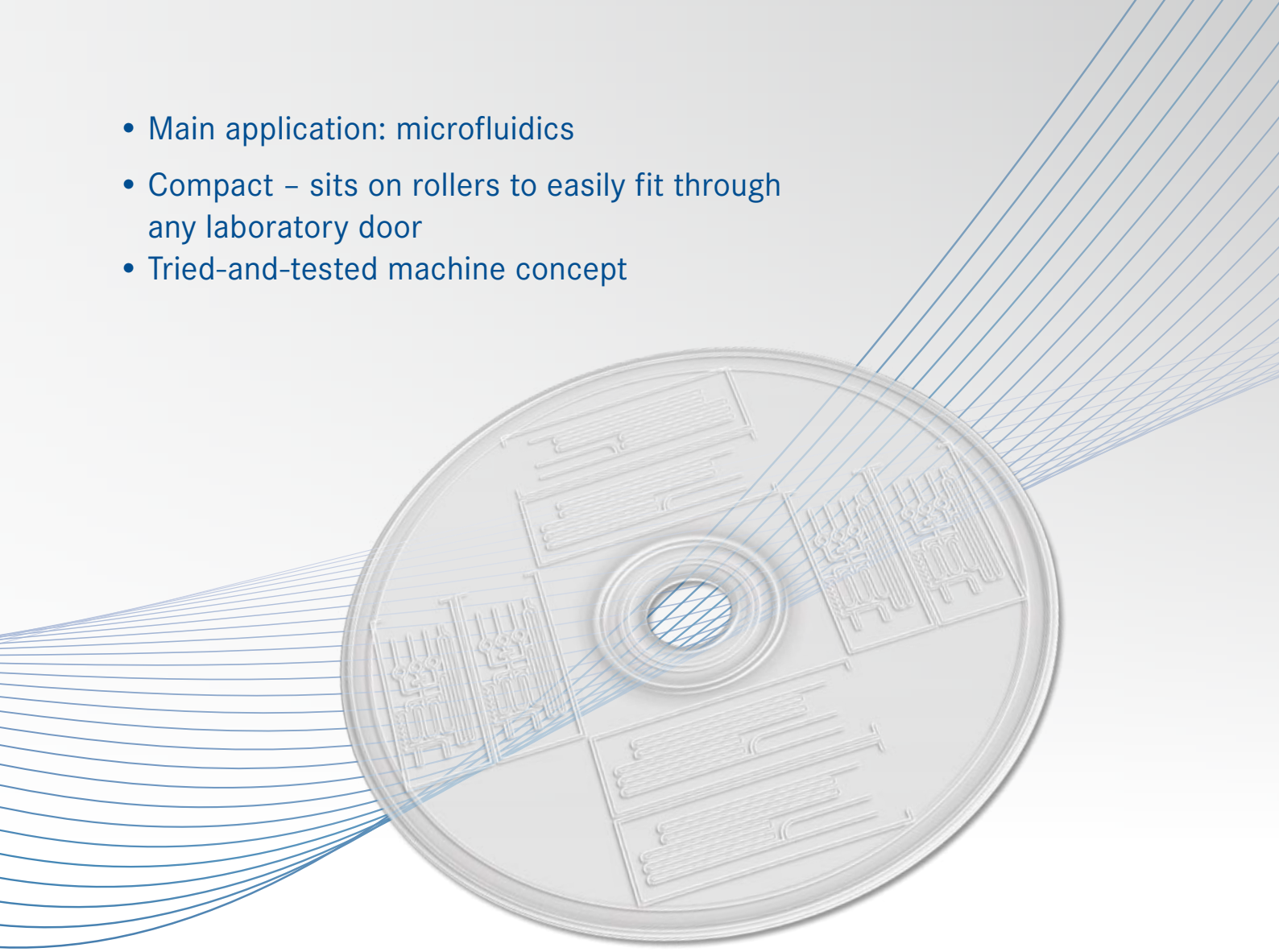
Plastics are being trusted to handle more and more complex functions in many products. This requires detailed specifications for the joining process to accommodate the new materials and applications. The ground-breaking, innovative laser welding system incorporated within the LPKF PrecisionWeld tool allows new areas of application, with increased precision and width of the weld seam, as well as new layout options.

Extremely Flexible

Laser plastic welding allows superior flexibility and performance. Advantages include inexpensive component holders, easily programmable welding contours and sophisticated quality assurance technologies that operate during or after the welding process. This ensures high variability, rapid development times, significant financial benefits associated with the component holders, and an exceptionally low rejection rate during production.

LPKF has a wealth of experience in laser welding. The Laser Welding Application Center provides interested parties with advice on an array of topics such as product design and process parameters, while also handling job-shop orders for series production and peak production relief.

- Main application: microfluidics
- Compact – sits on rollers to easily fit through any laboratory door
- Tried-and-tested machine concept



Benefits for Microfluidics Applications

Microfluidics applications, involving the analysis or precise dosing of liquids, have become increasingly significant in recent years. The channels used for the transportation of liquids in microfluidics devices are so fine that capillary forces override the effects of gravity. Channel widths of 100 µm are no longer uncommon. When these components are created using conventional methods, particles, additives or deviations from the planned welding geometry, they often produce rejects.

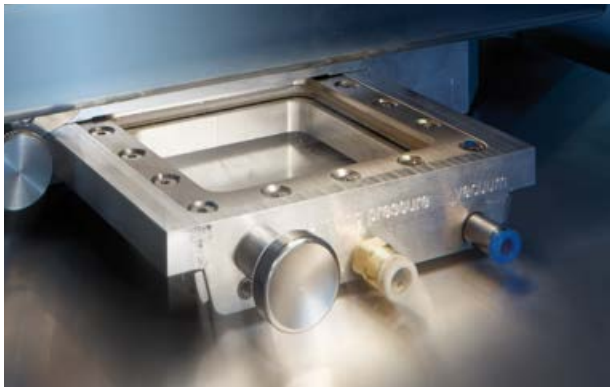
Rejects are less likely to occur when using transmission laser welding technology because it requires no additives and does not expose the components to mechanical or high thermal stress. Due to the small laser focus the thermal conduction is spatial limited and the weld flash is restricted. There are no unwanted particles.

The new LPKF PrecisionWeld adds another application to laser plastic welding: it is specially designed for particularly fine microfluidic weld seams. These fine weld seams have a width of only 100 µm. The positioning repeatability of 30 µm is highlighted by the name of the system – this level of precision is unprecedented and unmatched by any other technology.

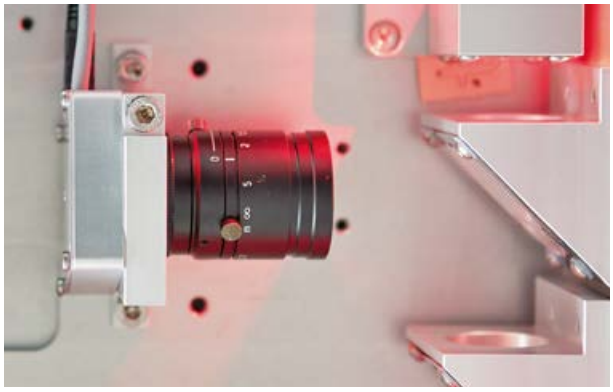
In addition, highly informative quality inspections can be integrated directly into the welding process: better safe than sorry – especially when producing sophisticated end products.

LPKF PrecisionWeld

- For prototypes and series production
- With a laser scanner and positioning table
- Automatic focus adjustment
- Integrated vision system



Exceptionally efficient: easy to use component holders



Vision system for fiducial identification

Rugged Machine Concept

The LPKF PrecisionWeld is based on a tried-and-tested machine concept used for 24/7 production. The laser system is initially laid out for manual operation to support prototype development and small-batch production. If manual feeding does not provide the required performance, the LPKF PrecisionWeld can also be equipped with suitable handling devices for highly efficient industrial mass production.

A Proven Foundation

Compact LPKF laser systems have been used successfully in industry and development for many years. The LPKF PrecisionWeld is the first unit to use a tried-and-tested machine concept from UV laser cutting for plastic welding applications.

The LPKF PrecisionWeld is most notable for its compactness and mobility: all it needs is a power cable and a compressed air line for operation. The system can be placed on rollers and moved to a new position at any time. The dimensions of the machine are only 875 x 1430 x 750 mm (width x height x depth) (34.5” x 56.3” x 29.5”). Merging scan fields extend the processing field to a maximum of 320 x 320 mm (12.6” x 12.6”).

The special design mechanically decouples the processing area and the machine housing. The laser scanner and the processing table are suspended to dampen vibrations.

Automatic Adjustment of the Focus Position

The LPKF PrecisionWeld system is the first to automatically align the focus position of the laser beam with the welding level. So an even more precise control of the welding process can be achieved.

Integrated Vision System

The LPKF PrecisionWeld comes equipped with a vision system that identifies contrastless topographic fiducial marks. These fiducials do not need to be printed because they can be created in a one-step process when the channels are integrated. This streamlines the process and boosts the overall processing accuracy.

When the fiducials are read in, the system references the pre-set component geometries to an accuracy of 2 µm and compensates for virtually any tolerances in the component holder as well as in the component itself – increasing the number of good parts.

Optimized Laser Source

At the core of the LPKF PrecisionWeld is a fiber laser with a wavelength of 1940 nm. Lasers with this wavelength can be used to join parts using the standard transmission laser welding method, combining a transparent component with an absorbent component, along with the newly developed LPKF ClearJoining technology (clear-clear joints).

Different Methods with the New Laser Source

Transmission laser welding has demonstrated superior handling of sophisticated and complex weld specifications. The LPKF PrecisionWeld surpasses existing technologies with the addition of the new clear-clear method.

Transmission Laser Welding for Optimum Joins

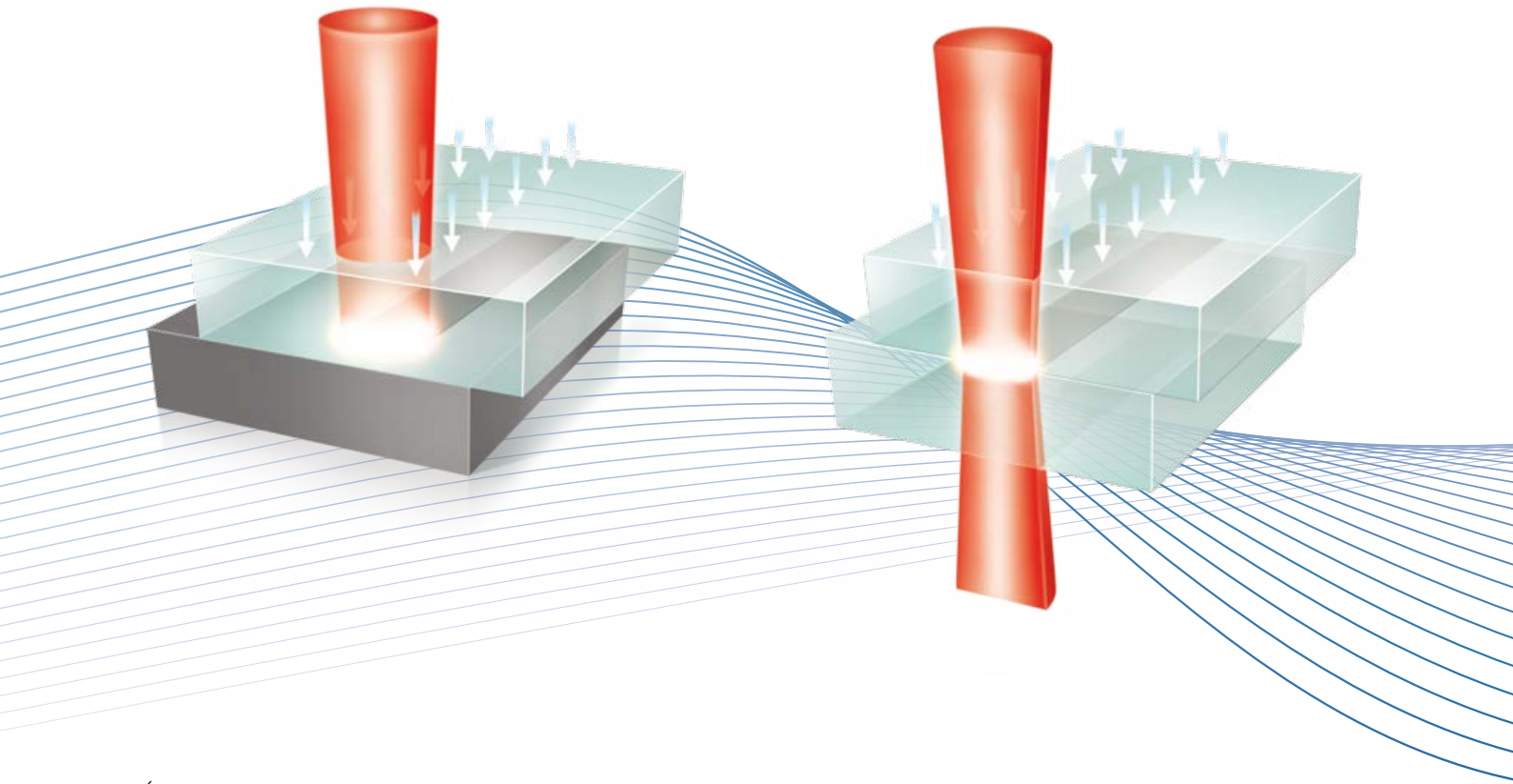
Transmission laser welding involves securely joining two components with different absorption properties together with respect to the wavelength of the welding laser. Both parts are often created from the same polymer, the difference being that the laser-absorbing joining partner has been pigmented with an additive – usually soot.

The laser beam passes through the laser-transparent joining partner to melt the underlying laser-absorbent part along the line of the weld seam. Thermal conduction assisted by a moderate clamping pressure causes the upper part to melt as well. When the seam has cooled down, both parts are permanently welded together. The strength of this laser weld seam is similar to solid plastic and very close to a welding factor of 1.

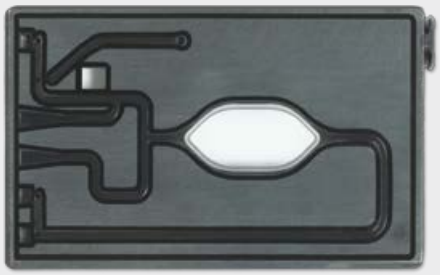
LPKF ClearJoining: Clear-Clear Welding

This new welding technology joins two laser-transparent partners without additives. Additives can not only block the approval process for certain products, they are also undesirable when the optical properties of the unadulterated material are stipulated by specific applications. The LPKF ClearJoining technology welds two identical polymer components together through the precision focus of the laser beam on the joining zone – the line of the weld seam between the two parts.

This welding technology uses a laser with a wavelength of 1940 nm. Welding is based on the principle of partial absorption, meaning that the laser beam can penetrate and warm up the entire thickness of the material. The maximum temperature occurs at the point of the highest energy density: in the focus.



Examples of Applications

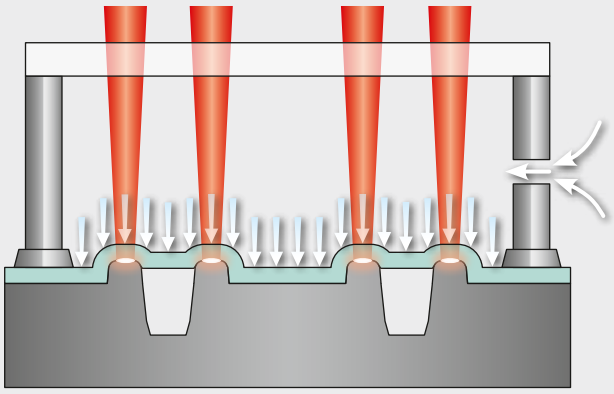


Cartridge for laboratory medicine

This atomizer dispenses an exactly predefined amount of active ingredients

The transparent microfluidic wafer was welded with the new ClearJoining technology

Perfect focussing on the weld seam – laser welded clear-clear joints without any additives



Differential Pressure Clamping Technology

Differential pressure clamping technology facilitates the creation of high-quality microfluidic components. The clamping tool holds the upper joining partner in an air-tight grip. Applying internal pressure creates a homogenous pressure ratio, and therefore virtually 100 % contact between the lower and upper joining partners. The differential pressure clamping technology allows burrs – created when the channels in the lower component are produced using hot stamping – to be reliably bridged over and positively locked.

Worldwide Service & Support

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Technical Data: LPKF PrecisionWeld 3000	
Laser class	1
Laser beam source	Thulium fiber laser
Laser wavelength	1940 nm
Processing field	320 mm x 320 mm (12.6" x 12.6")
Power supply	110 V / 220 V (50 – 60 Hz), (single phase), approx. 1.2 kW
Air supply	6 bar, 160 l/min (unoiled)
Diameter of the focussed laser beam	65 µm
Positioning repeatability	30 µm
Cooling system	Integrated air cooling unit
Ambient temperature	22 °C ± 2 °C (71.6 °F ± 3.6 °F)
Humidity	< 60 % (non-condensing)
Options	• Tablet PC for easy machine operation • SMEMA interface for automatic operation in a production line • HEPA fine filter to create a particle-free environment in the interior compartment
Required accessories	• Vacuum pump • PC with the following system specifications: Microsoft® Windows® XP or 7, 1 GHz processor or better, minimum 1 GB RAM, screen resolution minimum 1024 x 768 pixels, USB 2.0
Dimensions (W x H x D)	875 mm x 1430 mm x 750 mm (34.5" x 56.3" x 29.5")
Weight	360 kg (794 lbs)

LPKF
Laser & Electronics

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LPKF AG, 10029383-100316-EN

LPKF TMG 3	
Laser class	1
Laser wavelength	980 nm
Power supply	5 V DC via USB
Interfaces	USB, RS232
Diameter of the sensor aperture	3 mm
Focus diameter of the laser beam	~ 1.2 mm
Precision	≤ 1 % transmission (in ref. operating state)
Dimensions (W x H x D)	220 mm x 257 mm x 295 mm (8.7” x 10.1” x 11.6”)
Weight	3.5 kg (7.7 pounds)

The LPKF TMG 3 is calibrated with a measurement standard according to DIN EN ISO/IEC 17025 and is shipped with a works calibration certificate.

Features

- Optically power-regulated laser diode for stable test conditions with the wavelengths of typical laser plastic welding systems
- Homogeneous, rotation-symmetrical intensity profile of the test beam
- Fastening option for component-specific holding
- Integratable in production lines, optional control via SPS
- Meets DIN EN 9001 requirements for measuring tools and inspection equipment

LPKF Laser & Electronics

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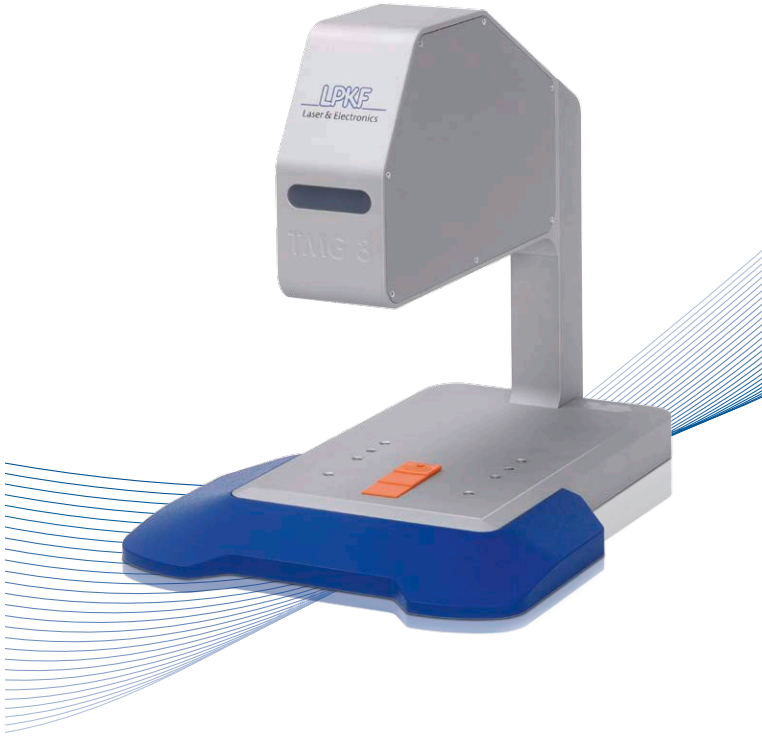
LPKF AG, 10066934-101016-EN

Simple Transmission Measurement for Plastics
LPKF TMG 3



LPKF Laser & Electronics

LPKF TMG 3

Calibrated Measuring Tool for Preventative Quality Assurance

The optical transmission of a plastic is crucial for the quality of the welded joint. This material property can be influenced by the upstream processes of compounding and injection molding. A quick and easy test of the optical transmission prior to laser plastic welding is an essential part of integrated quality assurance.

Better Safe than Sorry

The LPKF TMG 3 enables the transparency properties of plastics to be quickly and easily checked and proved. It only takes a few seconds to check that the actual transparency metrics match the set values in the process definition. Testing reveals any deviations in the materials before an unsuitable component enters the production process.

Easy and Reliable

The LPKF TMG 3 can be used directly in the production as calibrated measuring tool. It determines the amount of laser radiation transmitted through a sample of plastic pursuant to DVS Regulation 2243. The beam intensity measured without a sample in the beam path is the reference level. A laser beam is then sent through the sample and its intensity determined where the beam exits the sample. An optional component-specific holder ensures reliable and reproducible test results.

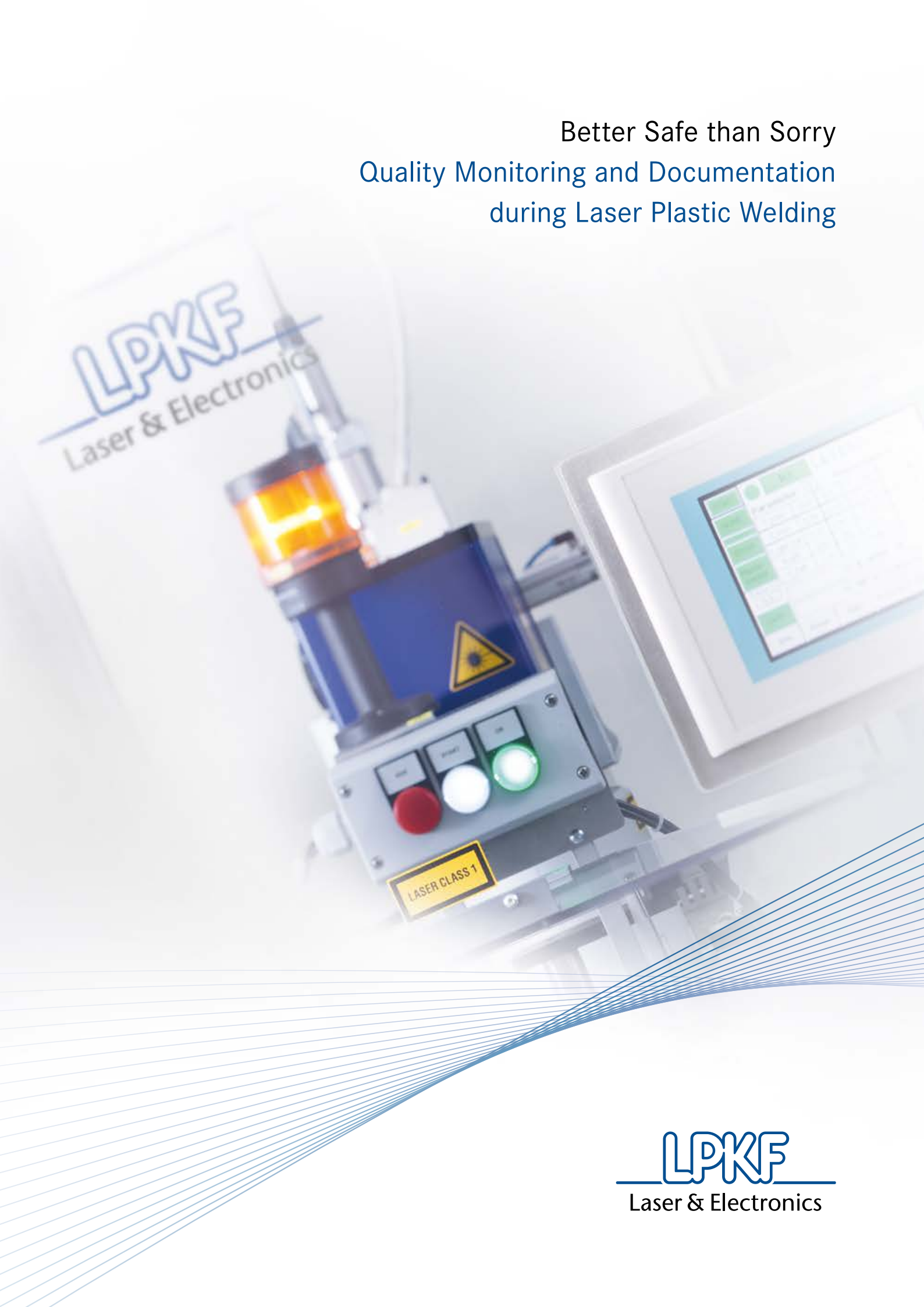
- Detects transmission fluctuations between components with an accuracy of ≤ 1 percent
- Insensitive to light interference
- Stand-alone operation via a PC and application software, or integration in the laser system and automation per SPS via an RS232 interface
- Power comfortably supplied via USB
- Laser class 1

Areas of Application

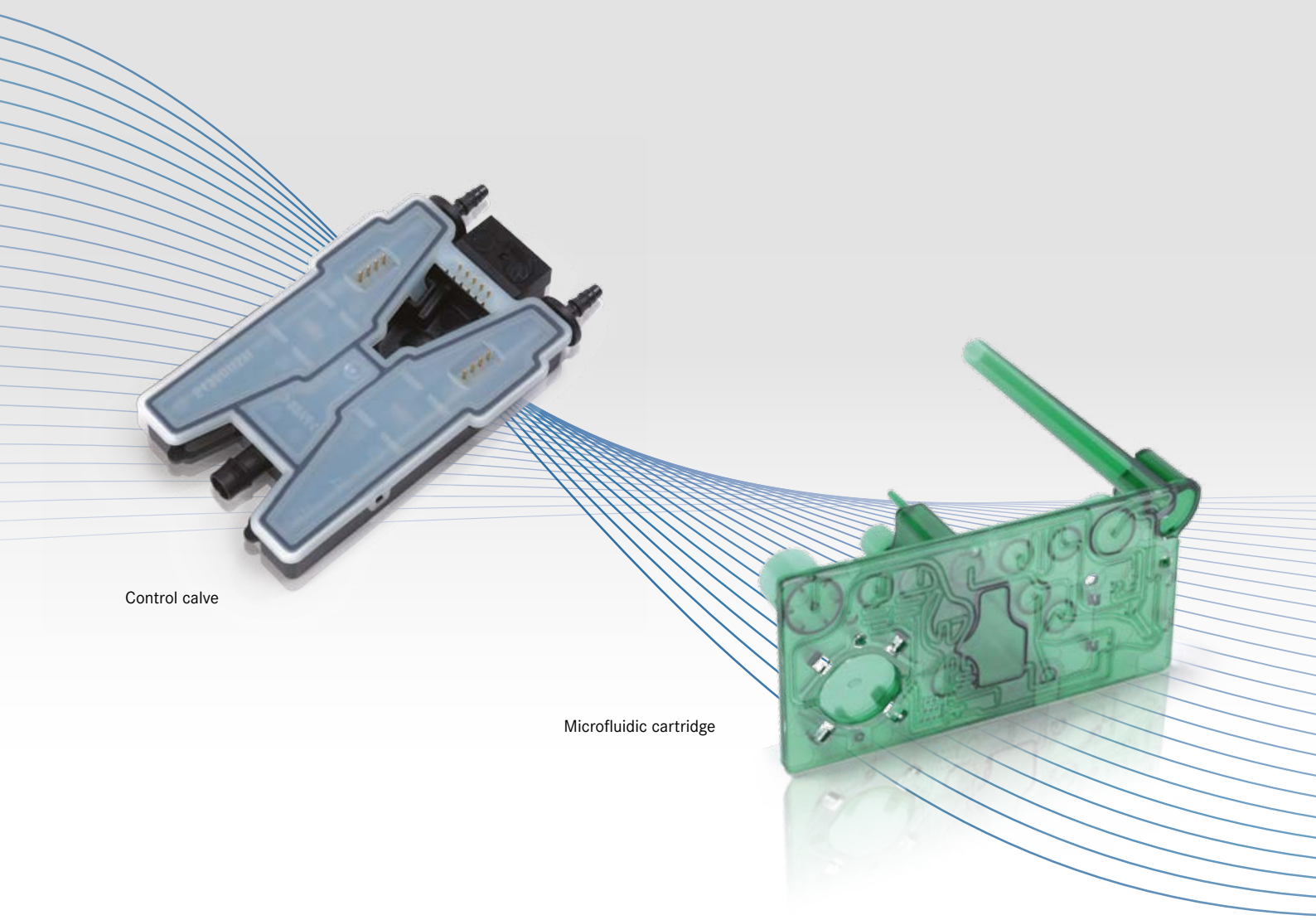
- Quality assurance of the compounding or injection molding process
- Weldability validation, process sampling
- 100 percent material qualification prior to the welding process or for incoming goods control

Better Safe than Sorry

Quality Monitoring and Documentation during Laser Plastic Welding



LPKF
Laser & Electronics



Control calve

Microfluidic cartridge

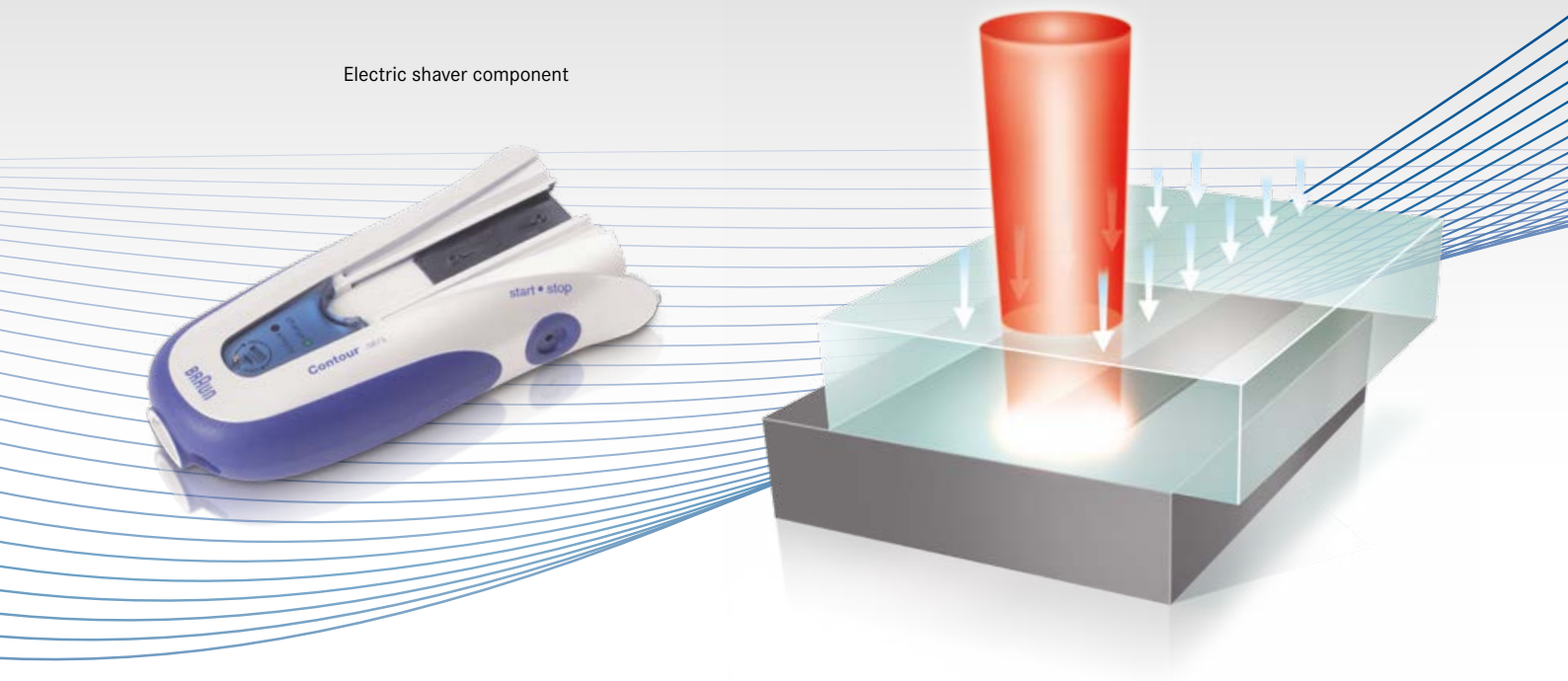
Economical, Innovative and with Assured Quality

LPKF plastic welding is a success story with three prime benefits: economic efficiency, technological superiority, and assured quality. Quality assurance is constantly gaining in importance – an area where LPKF and transmission laser welding have a great deal to offer.

Quality starts with a safe and reliable welding process, and continues with proper testing. The LPKF systems boast integrated process monitoring including regulation mechanisms which correct even the smallest deviations.

LPKF AG stands for innovative strength and an international presence. Backed by decades of experience, the company contributes its mechanical engineering and laser technology know-how today in the automotive sector, medical technology, electronics fabrication, and the production of solar cells.

LPKF WeldingQuipment GmbH is a market leader in the production of reliable laser welding systems and offers impressive system solutions for mass production.



Electric shaver component

Today’s Hottest Trend: Laser Plastic Welding

Modern laser plastic welding goes way beyond the boundaries of traditional joining methods. The principle: a laser beam penetrates the upper, laser-transparent component, causing the lower, laser-absorbing component to melt and bond. A moderate amount of pressure ensures that heat is also transferred to the upper component creating a common welded seam.

There are several laser plastic welding methods. LPKF primarily uses maskless technologies such as quasi-simultaneous welding (rapidly running the laser beam over the joining line several times), contour welding, radial welding, and the robot-assisted TwinWeld3D method for large free-form components.

Benefits of Laser Plastic Welding

Economic:
- Rapid product development
- Low Total Cost of Ownership (TCO)
- High flexibility
- Short cycle times
- Simple product solutions

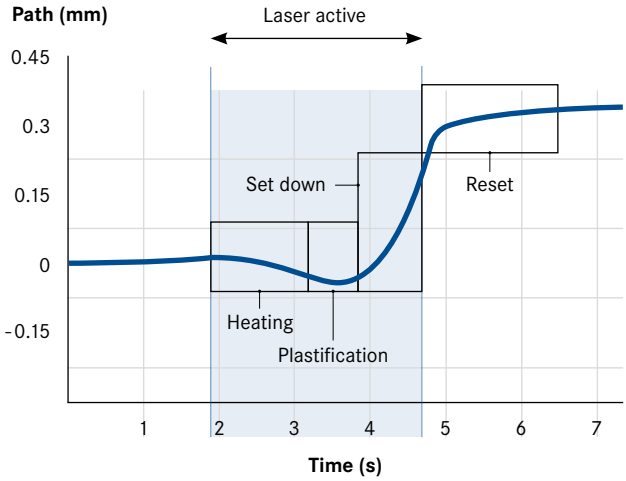
Technological:
- Online process monitoring option available
- Optically high quality welding seam
- Particle-free welding
- Minor stressing of the components
- No marking, no surface damage

Process Monitoring makes a Crucial Difference

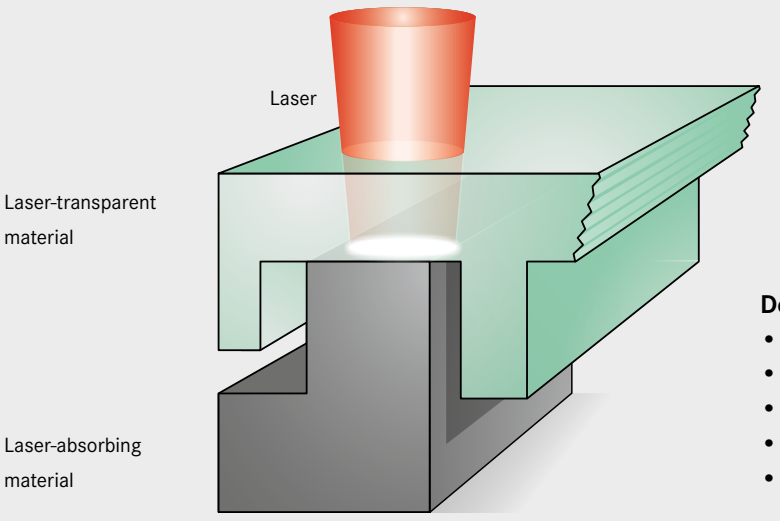
Laser plastic welding is already a very reliable method thanks to its intrinsic technology. On top of this, LPKF has developed a process monitoring system with special testing methods to check the reliability of the bond as the welding process itself proceeds. In special cases, the laser can even make corrections when the process is running to avoid expensive rejects. In addition, all of the parameters can be recorded during the welding process and used for end-to-end tracking & tracing. LPKF continuously further develops these techniques to satisfy the demanding requirements specified by the automotive and medical sectors. The most important methods at a glance:

Melt Travel Monitoring

Melt travel monitoring is the most rugged testing method. Suitable for quasi-simultaneous welding processes, this method allows detection of both direct and indirect errors. The principle applied is that only a specific amount of melted material is needed to satisfy the production tolerances of a component, no more and no less. The welding procedure is halted when defined limits are reached such as time, melt path or a fixed stop. This process allows the reliable creation of tight welded seams which satisfy protection classes IP67 and IP69K.



Design Example of Quasi-Simultaneous Welding



Design Considerations

- Configure the welding path
- Take collapse into consideration
- Seam path = welding path + collapse
- All round clamping edge
- Planned space for melt reservoir

Pyrometer Temperature Control Method

Pyrometric monitoring of the laser welding process delivers considerably enhanced detection rates. As developed by LPKF, this method offers the benefits of fast reaction times to temperature changes for the automated evaluation of welded seam quality.

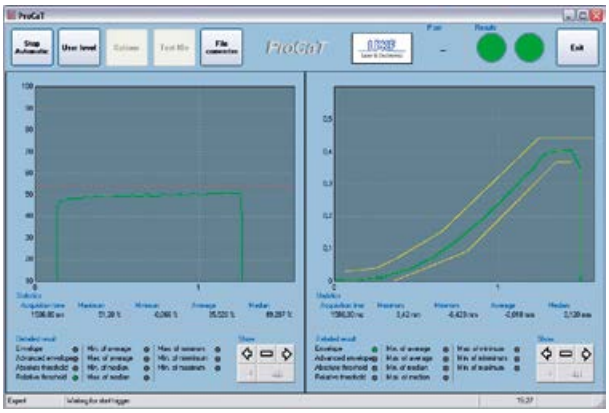
A pyrometer records the electromagnetic radiation in the infrared range (temperature radiation) to monitor the quality of the welded seam. The weld is considered satisfactory if the temperature curve remains within predefined upper and lower limits (the curve envelope). Surface errors such as burn marks or cratering in the area of the welded seam result in anomalies.

Pyrometer monitoring is **not only capable of controlling the process during contour and quasi-simultaneous welding, it also enables situation-dependent regulation** – the pyrometer signal is used to automatically control the machine to compensate for material fluctuations.

Burn Detection

Burn detection is a method used to reliably detect surface scorching of plastics welded with a laser. This second generation of burn detection systems is enhanced to identify errors on the radiation penetration side of the top layer. Scorches in practice often only measure a few tenths of a millimeter across and therefore have no verifiable influence on seam strength.

However, in some applications, such scorch marks are unacceptable for functional and aesthetic reasons.



Everything just perfect: Burn detection and melt travel monitoring guarantee faultless welding processes

The radiation emissions of such scorches range from the visible through to the infrared spectrum. If radiation is detected in these wavelengths, the burn emission pattern is easily distinguished from background noise.

Material Qualification with the LPKF Transmission Sensor

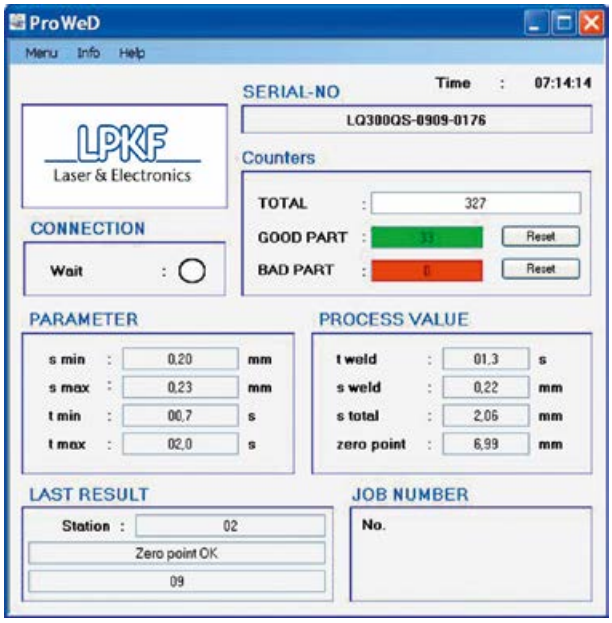
Materials with defined properties are essential for reliable welding results. The parameters in the welding process are matched to the transmission and absorption properties of the two parts being welded together. They can be easily detected: the mobile sensor LPKF TMG 3 marketed by LPKF measures the radiation transmitted through a plastic sample.

The inline-capable system illuminates an inserted component with the same laser wavelength during the welding process. The transmission parameters are determined within a few seconds and are ready for instant comparison with the original values.

Following qualification of the employed measurement standards by the National Metrology Institute of Germany (Physikalisch-Technische Bundesanstalt Braunschweig), LPKF calibrates the delivered TMG 3 in accordance with DIN 9001. Each measuring device is shipped with a calibration certificate and the measurement report. Thus, the TMG 3 is directly qualified for quality assurance that conforms to the standards.

Assuring Quality

There are many tricky aspects – so it is good that problems can be identified and nipped in the bud before they have an impact on the production process. Even better is when sources of potential error – such as the different transmission factors of the two plastic parts being joined – are compensated for in the production process by suitable control mechanisms. LPKF has developed the methods and the software needed here for simple integration within the production process.



Continuous process control for the long term assurance of product quality

Data Matters

An easy to operate, universal data interface: the LPKF ProCaT software records the measurement data from all the monitoring components and sensors, combines the results, evaluates them, and communicates automatically whenever required with the machine control system. The data from melt-travel monitoring, burn detection, reflection diagnosis and pyrometer control, deliver reliable information on the weld quality, and comprehensive process documentation.

LPKF Laser Welding also supplies the ProWeD software for welding data evaluation. It saves all the parameters for the welding procedures from the machine control, and collects them in one file for statistical analysis. ProWeD handles continuous quality control, is a process development tool, and documents the performance of the welding process for as long as you need.

LPKF's Process Capturing Tool
ProCaT

Certified Quality

LPKF's process monitoring methods integrate perfectly within your own in-house systems – to comply with the different quality standards operating in different sectors. The laser welding systems for LPKF show the process data separately for each and every component – for end-to-end tracking & tracing. The continuous measurement series form the platform for Six Sigma process performance analysis.

LPKF therefore satisfies the conditions for process evaluations pursuant to:

- DIN ISO 9001
- ISO/TS 16949 (Quality management systems – special requirements when applying ISO 9001:2008 for volume and spare parts production in the automotive industry)
- VDA 6.x – Regulations for the German automotive industry covering services and production tool manufacture
- GMP (Good Manufacturing Practice) – Regulation for quality assurance of production processes and environments for the production of pharmaceuticals, active substances and medical products

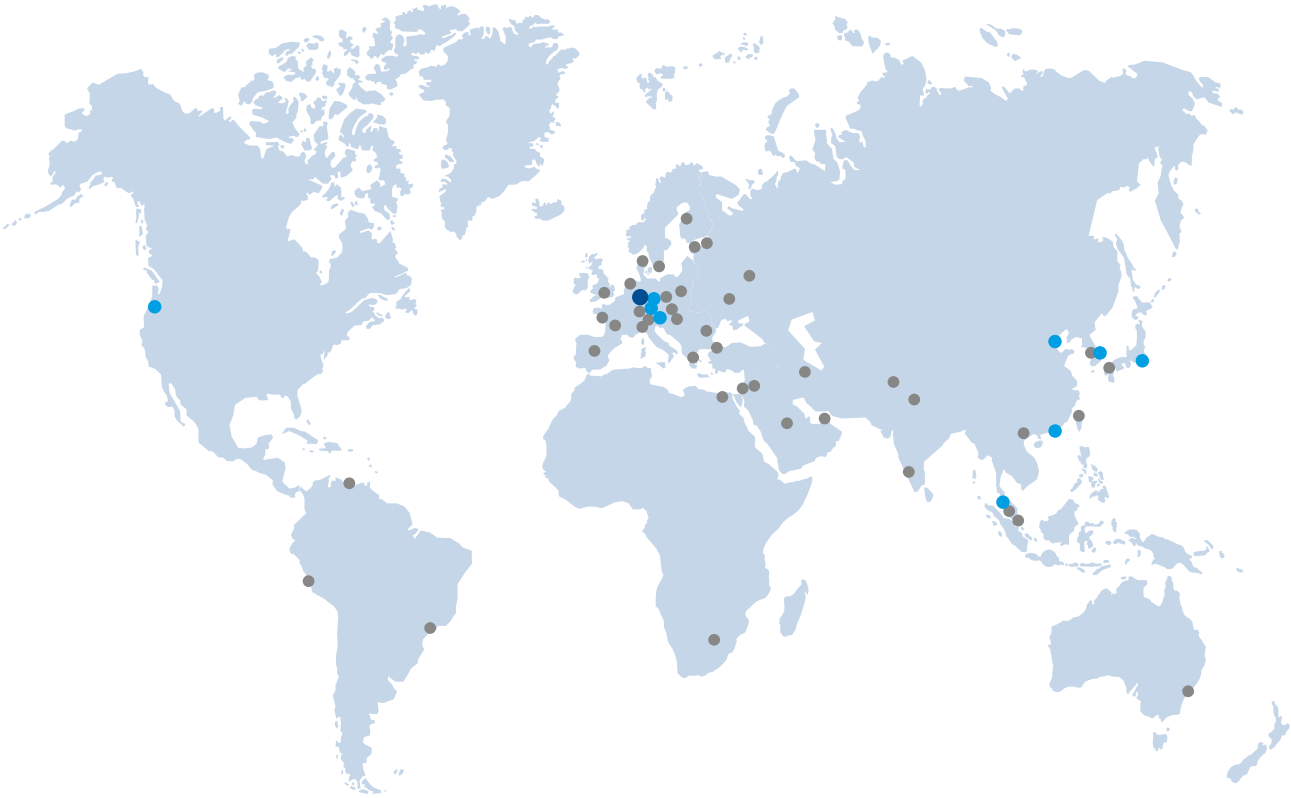
Safe process, high component quality – all certified.

Laser Systems for the World Market

LPKF has been active in laser material processing for many years – with high performance systems for industrial production. Laser plastic welding combines its own development potential with global mass production experience.

Full Round-the-Clock Service

The clients of LPKF Laser & Electronics AG enjoy full round-the-clock service to guarantee optimum availability of their equipment. Service technicians or engineers are available for commissioning the LPKF welding systems and to ensure that production starts smoothly. When the welding systems are running, highly qualified service staff provide professional support via hotlines, remote diagnosis or on-site trouble shooting.



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LPKF Service & Support

LPKF provides worldwide premium customer support. Learn more:
www.lpkf.com/support

LPKF
Laser & Electronics

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www.lpkf.com

Part of LPKF Group

Reliable efficiency
Engineered for safety
User-friendly
Eco-friendly

Made in Germany

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www.jenko-sternberg.de

Photos may also show optional accessories.

LPKF AG, 10005666-051017-EN

LPKF Laser Welding Material Compatibility Chart

transmissive / absorbing	ABS	ABS/PA	ASA	COC	MABS	PA 12	PA 612	PA 6	PA 6-3-T	PA PACM12	PA 66	PBT	PBT/ASA	PC	PE-HD	PE-LD	PEEK	PES	PMMA	POM	PP	PPS	PPSU	PS	PSU	PTFE	SAN	TPE
ABS	++		++	×	++			×			×	++	+	++	×	×		+	++	+	×			×	+		++	++
ABS/PA	++		++		×			++			++	+	+					+		×	×				+		++	
ASA	++		++		×			×			×	++	++							×	×						++	
COC	×			+										×					+					×			×	
MABS	++		×		++			×			×	×	×					×		×	×				×		×	
PA 12						++	++	−	++	++	×	−			×	×		−	×	×	×							
PA 612						++	++	+	++	++	×	×							×									
PA 6						−	−	++	++	−	++	×			−	−		×	×	×	−			+				
PA 6-3-T						+	++		++	−	++	−		×				−	×	×	×							
PA PACM12						+	++	×	++	++	−	−						×	×	×	×							
PA 66						×	−	++	++	×	++	×		−	−	×		×	×	×	−	×		+				+
PBT	++		++		×	×	+	−	×	×	×	++		++	×	×		+	×	×	×			×	+		++	
PBT/ASA	+				×			×			×							+		×	×				+		×	
PC	++			×					−		−	++		++	×	×			++		×	−		−			++	+
PE-HD	×					×		−			−	×		×	++	++			−	−	×			×			×	
PE-LD	×					×		−			−	×		×	++	++			−	−	++			×			×	
PEEK																	++											
PES	+		×		×		×	×			×	+	+					++		−	×			×	++		×	
PMMA	++			+		×	×	×	×	×	×	−		×	−	−		×	++	+	−			+			++	
POM	−		×		×	×	×	×	−	×	×	×	×		−	−		−	+	++	×			×	×		×	
PP	×		×		×	×	×	−	×	×	−	×	×			++		×	−	−	++	×			×		×	++
PPS						×	×	−		−	−			++				−	×	−	×	++					−	
PPSU																							++					
PS	×		×	×	×			+			+	×	×	−				−	+	×	×			++	×		−	
PSU	+		×		×			×			×	+	+					++		×	×				++		×	
PTFE																										++		
SAN	++		++	×	×			×			×	−		+	×	×			++	×	×			−			++	
TPE											+			+							++			×				++

++ Excellent weld + Good weld − Poor weld × No weld No research available

Data in this table can vary according to the wavelength of the laser.

Transmission Laser Welding of Plastics

Design Guidelines “light”

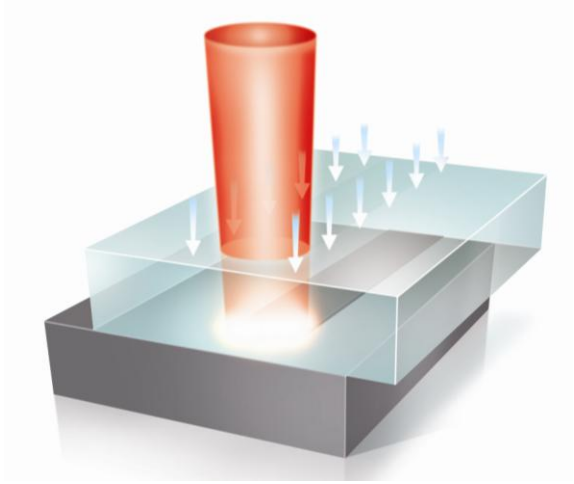
Introduction

The purpose of this document is to provide designers and engineers, in the concept and design phase of new products, with a brief understanding transmission laser welding of plastics.

Basic Laser Welding Process

Laser plastic welding is a method of bonding two or more thermoplastic components together. Although there are many methods for joining thermoplastics, laser plastic welding has a few clear advantages: higher joining quality, minimal resulting flash or particulates, higher quality controls, less stress to the component and the ability weld complex and intricate shapes.

When plastics are joined by laser welding, the laser beam passes through the laser-transmissive upper part to transfer its energy to the lower, laser-absorbent part. Moderate clamping pressure ensures reliable heat conduction between the two joining partners. The weld seam plasticizes, and sets after cooling to form a secure, strong weld.



There are four important requirements for the laser welding process to occur. These four points will be addressed in detail in the following section.

Medical: microfluidic cartridge
Highlights: precise weld seams, no particulates left from process

Important Requirements

1. Laser Transparent Top Layer
The upper joining partner must be sufficiently transparent to the wavelength of the laser to allow the laser beam to pass through the component. Plastic that is transparent to laser light is either pure or contains non-absorbent pigments.

Laser-transparent plastics are not necessarily transparent to the human eye. The strength of the energy needed in the laser beam to achieve proper welding at the joining line process is dependent on the transparency of the transmissive plastic in the upper layer. The transparency is dependent on the additives, fillers and the thickness of the material.

2. Laser Absorbing Bottom Layer
The laser absorbent layer is responsible for turning the remaining laser energy, once passed through the transmissive layer, into heat at the interface of the two layers.

A commonly used additive to make plastic absorbent for IR laser light is carbon black (typically 0.2-0.4% by volume) since it is very economical. However, there is also a variety of other additives, including colorings, which are IR absorbent.

Note, it is possible to weld two pieces of clear plastic to one another, either using a special additive, (Clearweld™ by the Gentex® company) or by using special laser wavelengths.

3. Material compatibility
The two polymers, which are to be joined, must be of the same plastic family with similar resin properties to be joined successfully; otherwise one part may melt or burn and the other will be unaffected.

The following materials are known to have been successfully welded: PA 6, PA 66, POM, PBT, PC, ABS, PP and PE in their pure form. For a more detailed listing of compatible plastics please request a “Materials Compatibility Chart” from a LPKF Laser Welding specialist.

4. Contact
It is paramount that heat energy, generated on the surface of the lower layer, be transferred to the upper layer so that it may become molten as well. In order for conduction to occur the two layers need to be in contact during the welding process.

Contact and pressure are typically accomplished with various methods of clamping devices, see letter “G” from Figure 1 below.

Design Considerations

The follow requirements need to be addressed in your part design for a successful laser plastic weld.

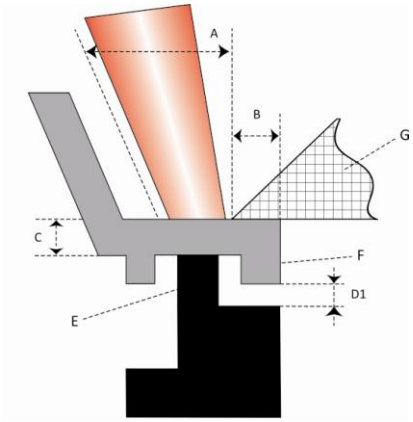


Figure 1 – Pre-Collapse

Melt-Collapse

Melt-collapse (*D1 and D2, Figure 1*) is the distance the joining partners travel as they move together under clamping pressure. This collapse allows for material fusion and a bond to occur. If joining two flat pieces, a weld rib (*E, Figure 1*) will be required to allow for melt-collapse to take place.

Figure 1, above, represents a joint prior to collapse, where figure 2 shows the same joint after melt-collapse has taken place. Notice the weld flash (*H, Figure 2*) from the compressed rib.

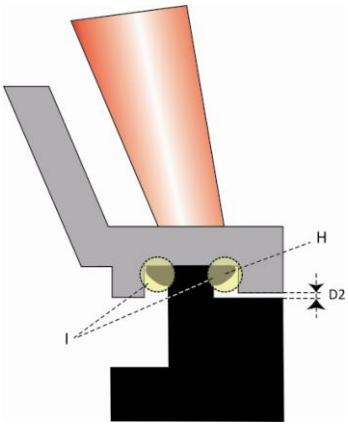


Figure 2 – Post-Collapse

Beam Accessibility

Parts need to be designed to allow direct access for the laser beam to the weld joint, shown as *"A"* in figure 1. Accessibility should take into consideration joint width plus part and positional tolerances.

Joint Design Legend

Transmissive Layer

Absorptive Layer

A - Beam accessibility
B - Clamp tool spacing
C - Top layer depth
D1 - Melt collapse before joining
D2 - Melt collapse after joining
E - Weld rib
F - Melt cover
G - Clamping tool
H - Weld flash
I - Flash/melt blow-out zone

Clamping technology

There must be an adequately large clamping surface on the cover to ensure the optimal application of pressure on the zones adjacent to the weld seam. The workpiece carrier must also be designed to provide good support for the housing in the zone around the root face.

Very good and reproducible positioning of the component in the workpiece carrier is crucial for uniform clamping, and the correct tracking of the joint line by the laser. This ensures that the quality of the welding results is always consistent.

Consultation and Contact Information

This document is intended as a brief introduction to laser plastic welding. Please understand these are only guidelines and your application may vary from them.

We recommend you consult a LPKF Laser Welding specialist during your design process. Please, contact us for design/feasibility advice or for sample runs.

Inquiries can be sent to:

LPKF Laser & Electronics AG
Laser Welding Division
Alfred-Nobel-Str. 55-57
90765 Fürth
Germany

E-Mail: **info.laserwelding@lpkf.com**
Or call us at **Tel. +49-(911)-669 859-0.**

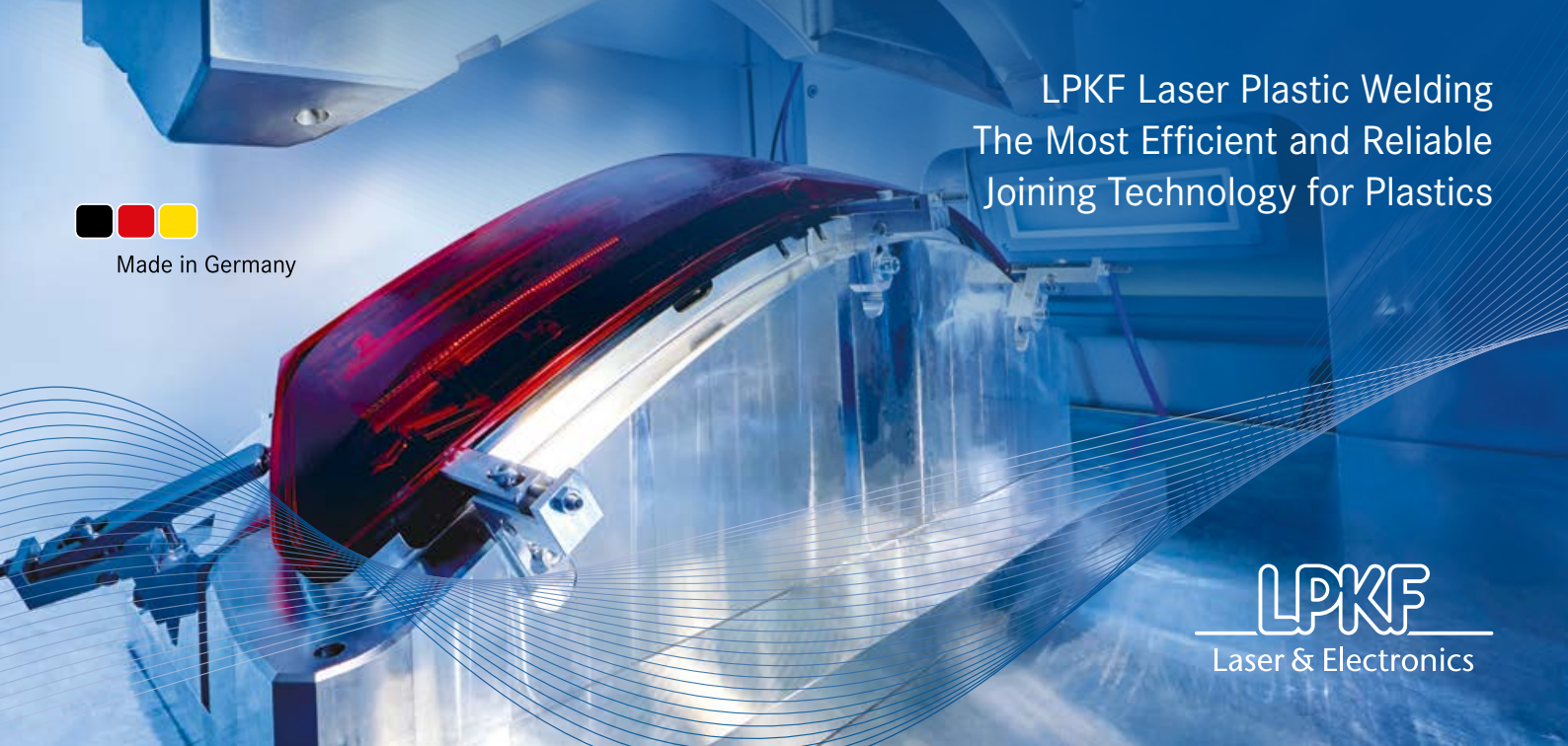
Here are a few details we recommend having available when you contact us:

- A basic summary of your application
- Computer model or specifications
- Material Information
  - Types of plastic
  - Number of layers
  - Thickness
- Desired cycle time
- Parts per year
- Seal requirements
- Other requirements:
  - Strength/load force
  - Optical
  - Function
  - Tolerances
  - Other
- Do you already have experience with laser welding of plastics?

Automotive: electronic sensor
Highlights: hermetic seal, stress free process will not damage sensitive electronics.

Medical: micro-atomizer
Highlights: ultra small and precise welds, no contaminating particulates or flash

Automotive: Hyundai Equus tail light
Highlights: large size, complex shape and aesthetically pleasing welds



LPKF Laser Plastic Welding
The Most Efficient and Reliable Joining Technology for Plastics

Made in Germany

LPKF
Laser & Electronics

Better Products Generated Faster Thanks to LPKF Laser Plastic Welding

A core capacity of laser technology is the joining of plastics. Compared with other joining technologies, the material-preserving process impresses through its cleanliness, precision, and cost-effectiveness. Laser plastic welding is especially recommended when the overall component must meet the highest demands for quality and durability.

The system portfolio from LPKF covers laser systems for reliable welding of very small to large parts with weld seam widths of 100 µm to several millimeters. The systems feature an impressively long service life and can be used as standalone machines or integrated into production lines.

On the following pages, we will present LPKF's application areas, machines, and offerings. If you have any questions or wish to request a sample of a welded part, LPKF representatives around the world are available to help you.

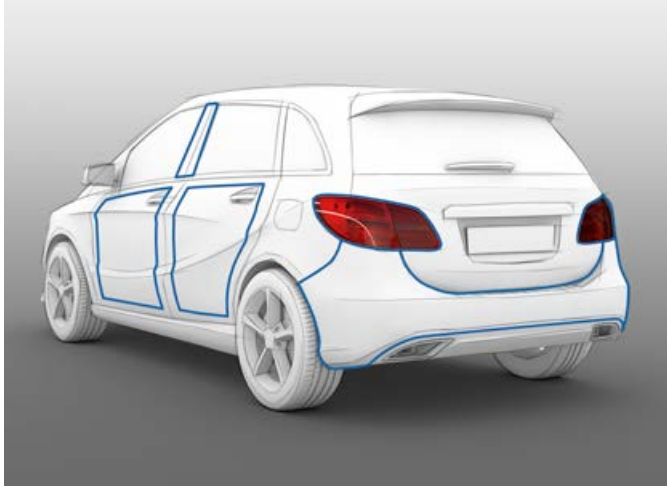
Contents

Industry Know-how for Reliable and Economical Plastic Welding

Plastics can be found today in and on nearly all industrial end products. We know the exact requirements of our customers with respect to the result of the joining process, especially in our three core industries of automotive, medical technology, and consumer electronics.

We use our long-standing knowledge of standards, regulations, requirements, and challenges in the respective industries to achieve the best possible results. Combining that with our comprehensive know-how in laser plastics welding, we can pinpoint the optimum application-specific solution.
Countless products – from small electronic housings to large valves – have already been produced using our machines, and the number keeps growing every day. LPKF welding machines are at home in many industry sectors. See for yourself.

Automotive



High-quality Plastics – High-quality Joints
LPKF is a key partner to the automotive industry. The long-lived LPKF laser plastic welding systems are established in the automotive industry, where they provide for high yields.

Profit from our lengthy experience. Fast and efficient 24/7 production through laser plastic welding. For your best-in-class products.

Vast Array of 3D shapes
Taillight – precisely welded with the PowerWeld 3D 8000

Cylindrical Bodies
Valves: reliably and securely welded – quickly and easily

Extreme Loading
Resistance and pressure – laser-welded tire pressure sensor

Complex Areas
Perfect contour welding for comfortable vehicles

Premium Look
Illuminated door sill guard on a premium-class car

Medical Technology

Reliability: Traceable, Repeatable Processes, Purity in the Application

We are big on process reliability and quality assurance. Because we know: compliance with specific purity conditions and process validation are important factors in the production of plastic parts used in medical technology.

Clean, fast, flexible, suitable for clean rooms, and reliable: with the LPKF laser systems for plastic welding, reliable, hygienic, and hermetically sealed joints can be produced between plastic parts without (chemical) additives, foreign matter, or particle loading.

Cylindrical Bodies
A laser is used in a radial welding process for joining small to large cylindrical bodies made of plastic: catheters, valves, and pins.

Cartridges
Fine channel geometries precisely executed – for perfect diagnostic results without turbulence, additives, or particles

Housings
Laser-welded housings – truly tight with perfect, hygienic joints and the appropriate appearance

Transparent Parts
Transparent plastic parts laser-joined – for microfluidics or for parts that must be transparent for esthetic or functional reasons

Consumer Products

Flexible production, precise results
Production of wearables, watches, in-ear headphones, or other exclusive plastic components – manufacturers of consumer goods profit from laser plastic welding: it lowers the reject rate, improves the esthetic quality, and saves money through the especially economical production process.

If, for example, delicate electrical components need to be encased in plastic housings, laser welding is the ideal joining technology. Precise and absolutely tight seams for complex 3D geometries or machining sizes in the micrometer range, compliance with strict hygiene directives, and flexible production planning – what more could you ask for?

Laser-welded Shaver
Watertight and precisely joined with an LPKF laser welding machine

Pool Lighting
So that the water in the pool shines especially beautifully, LPKF machines generate reliable weld seams around the delicate lighting electronics

Effective use for beautiful colors
Functional and visually appealing results for decorative cosmetics

Your Idea ...

Getting Started is Easy
Every project is special. We know that. And that is why we are happy to take on your assignments. On request, we can recommend materials or designs for developing products that are as efficient as possible and that are economically and technically superior to conventional materials and designs. We select the right machine for you and calculate the optimum process parameters.

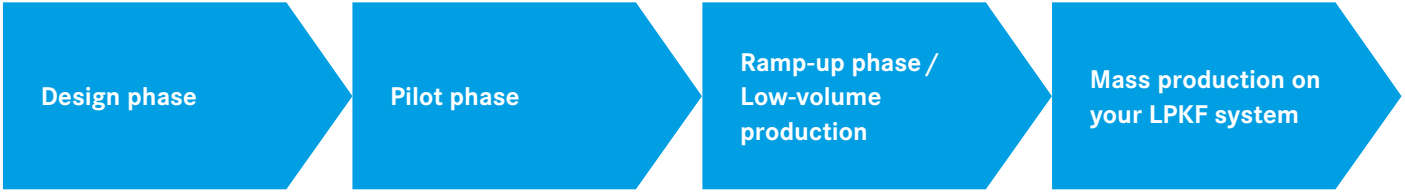
We are at your side from the concept stage to the final product. We know what we are doing and help you reach your solution.

... Our Solution

Our Expertise for Your Success
With laser technology, you obtain reliable, fast, high-quality results. Our experts would be happy to advise you. Our machines “Made in Germany” stand for safe and reliable technology, and our employees for the innovative art of engineering.

Application Center for Evaluation and Consulting
Our physicists and application experts can especially support you in the testing of new materials and designs. They develop optimized production processes – for the best product at the lowest cost. For this, LPKF has special application centers in North America, Europe, and Asia equipped with the latest laser technology from LPKF.

We Accompany You – From the Initial Idea to the Finished Product



Application consulting, materials consulting, feasibility studies, materials analysis and testing.

Sampling according to your 2D or 3D drawings and parts, prototype production, process design.

Production at the LPKF application center or LaserMicronics.

Low and medium volumes can be produced by our partner LaserMicronics; backup solutions are possible.

At Home in the Plastics Processing Industry

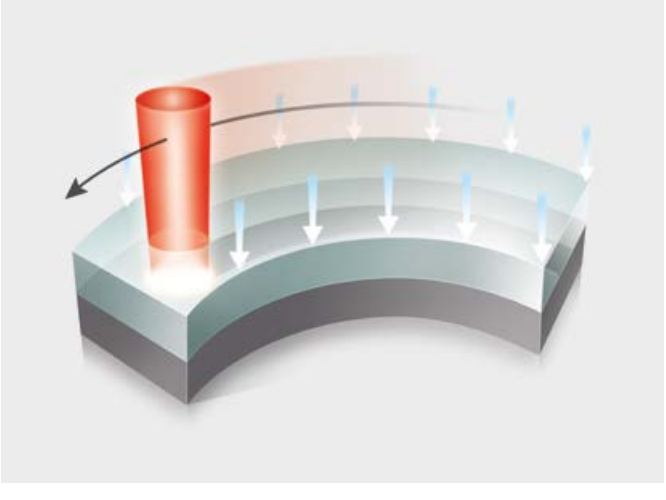
Packaging, electronic component, or watch? Toys, a ship's interior, or designer furniture? Laser transmission welding is used for many everyday objects made of plastic due to the host of advantages it offers:

- Precise weld seams in visible areas
- Invisible weld seams through clear-clear joints
- Absolute imperviousness of weld seams up to IP 67
- Complex 3D contours and large free-form parts realizable
- Possibility of welding particularly thin materials such as foils
- Welding of particularly small materials with seam widths in the micrometer range
- Flexibility for production planning

Experts for Special Requirements

Our longstanding expertise in laser plastic welding allows us to take an informed look at materials, geometries, end products, and application- and industry-specific conditions. Through this, you find the right solution for the challenges in plastic product manufacturing.

What is Laser Plastic Welding?



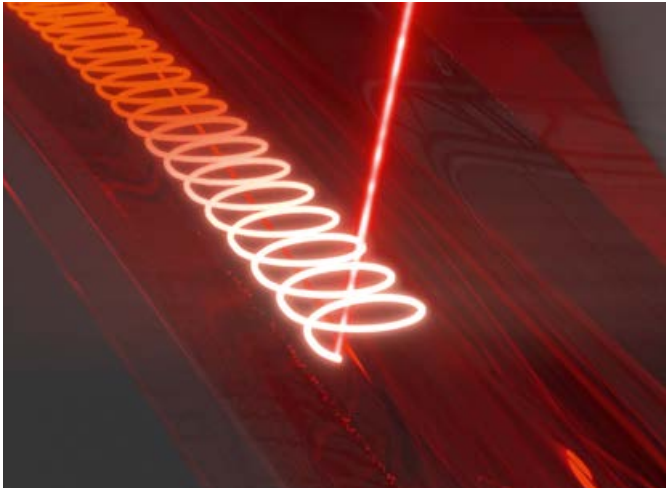
In many application areas, laser plastic welding is replacing conventional joining techniques such as adhesive bonding and ultrasonic welding. In cost- and quality-sensitive industries such as automotive, medical devices, and consumer goods, production is increasingly being converted to efficient laser welding technologies.

A molding made of a material that is transparent to the laser wavelength is joined to an underlying part, which absorbs the laser energy. The laser beam penetrates the laser-transparent part and is focused on the laser-absorbing part, melting its surface. The upper part is pressed against the lower part with a defined force; due to heat conduction, the upper part is also plastified.

This produces a reliable weld seam without damaging the surface. Laser plastic welding offers a number of advantages: low-cost tool holders, easy-to-program welding contours, and smart process monitoring during the welding process. Laser plastic welding leads to low reject rates and a hygienic, absolutely particle-free, attractive joining result.

Process Parameters

- Laser power [W]
- Speed [mm/s]
- Joining pressure [N/mm²]
- Material properties



Laser Welding Systems for Line Integration – LPKF InlineWeld Systems

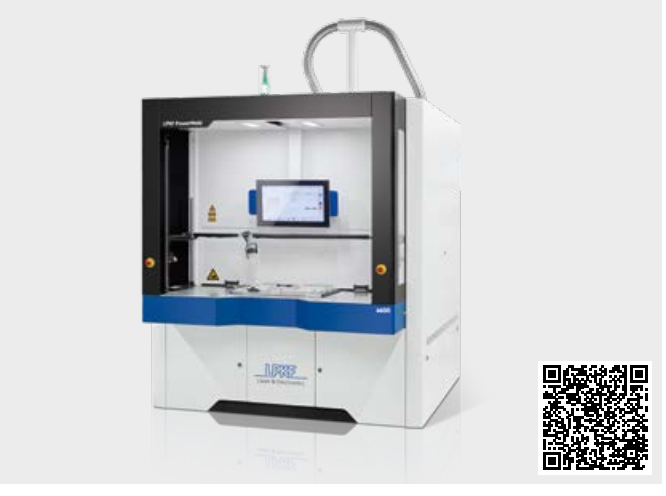
The systems in the LPKF InlineWeld series are designed for integration into production lines at customer plants. The processing unit is very small and flexible and can easily be integrated into automated workpiece carrier systems and rotary tables. The supply components are situated in a separate control cabinet. The LPKF InlineWeld systems generate weld seams of any shape. By changing the control data, you can directly adjust the welding contour.

LPKF offers suitable laser welding machines for all needs and wants: universal systems, variants with especially fast cycle times and 24/7 availability, or combinations of individual machine elements up to complex robot stations.

Laser Welding Systems for Standalone Applications – LPKF PowerWeld Systems

The LPKF PowerWeld machines were developed as low-cost solutions to meet a wide range of requirements in plastic welding. The laser, the control unit, and the cooling unit are situated in a compact housing. Various laser sources and supply systems such as rotary tables in combination with efficient control and process monitoring systems ensure optimum workpiece quality and productivity.

The maximum possible machine availability is guaranteed thanks to high-quality components, while the integrated inline process monitoring ensures product quality. As modular solutions, the systems can easily be adapted to special customer requirements.



Laser Welding Systems Specifically for Large Plastic Parts

Motor vehicle taillight

For industry sectors such as the automotive sector in which large plastic parts are joined, LPKF developed two special systems: LPKF PowerWeld 3D 8000 and LPKF TwinWeld 6000.

As different as the welding processes used in the two machines are, the results are equally excellent: both systems provide for economical production of parts with perfect weld seams in terms of quality and appearance, even for complex 3D geometries.

Reliably tight weld seams make use for the automotive sector and for sectors requiring IP67 protection possible.

Standardized Calibrated Transmission Measuring Device – LPKF TMG 3

For the laser plastic welding process, two parts with different absorption rates are required. The upper part must at least be partially transparent to the laser beam.
In order to avoid bad parts, the calibrated LPKF TMG 3 transmission measuring device determines the amount of laser radiation transmitted through a plastic sample in accordance with DVS Guideline 2243. With a maximum measurement accuracy, it detects deviations in the transmission characteristics of ≤ 1 % and thereby provides for optimum weld seams. The measurement results from different devices around the world can be compared with one another.
Saving of data for complete traceability is possible. The LPKF TMG 3 can be integrated into an LPKF laser welding system or operated individually.

LPKF Software: Easy Operation, Exact Results

Especially for complex processes, the software is one factor that determines the flexibility and success of production. The new, specially developed software from LPKF radically simplifies machine setup. It takes over the 3D CAD data, calculates the optimum welding contours, and transfers the information directly to the machine control system.

Repeated manual machine adjustment is superfluous. The LPKF machine calibration enables identical quality to be achieved at the push of a button. With a single data set, calibrated machines deliver results that are repeatable everywhere in the world at all times. This is as reliable as it is simple. And the software allows the integration of additional features such as coaxial camera coupling for component and weld contour recognition.

LPKF Worldwide: At Your Service and On Site Fast

Service and Support

Laser Systems for the World Market
For more than 40 years, LPKF has been active in material processing using laser beams – with high-power systems for industrial manufacturing. With development and application know-how as well as experience in high-volume production, LPKF is an important global partner to companies involved in plastic parts joining.

24-hour Complete Service
For the optimum availability of your systems, you, the customer, receive comprehensive end-to-end service from LPKF. Service technicians and engineers will gladly perform the commissioning of the LPKF welding systems to ensure a smooth start to production. As soon as the welding systems are operating, highly qualified service personnel provide professional support – whether by phone, through remote maintenance, or via problem-solving on site. LPKF has put together various packages from basic to premium service to accommodate various service and support wants and needs. In addition, with replacement parts inventories worldwide, you are sure to receive high-quality replacement parts in no time.

Service Packages: Our Tailor-made All-round Carefree Offerings for You

- Fast response times for minimal standstill times for your machine
- Qualified support by e-mail and telephone
- Free remote support

- Failure probability is greatly lowered
- Preventive maintenance protects your investments
- Easy planning thanks to planned maintenance
- Basic package included

- Complete service and full cost control
- Maximum machine availability
- Warranty period of up to five years
- Basic and Classic packages included

Contact Your LPKF Representative:

sales.laserwelding@lpkf.com

Made in Germany

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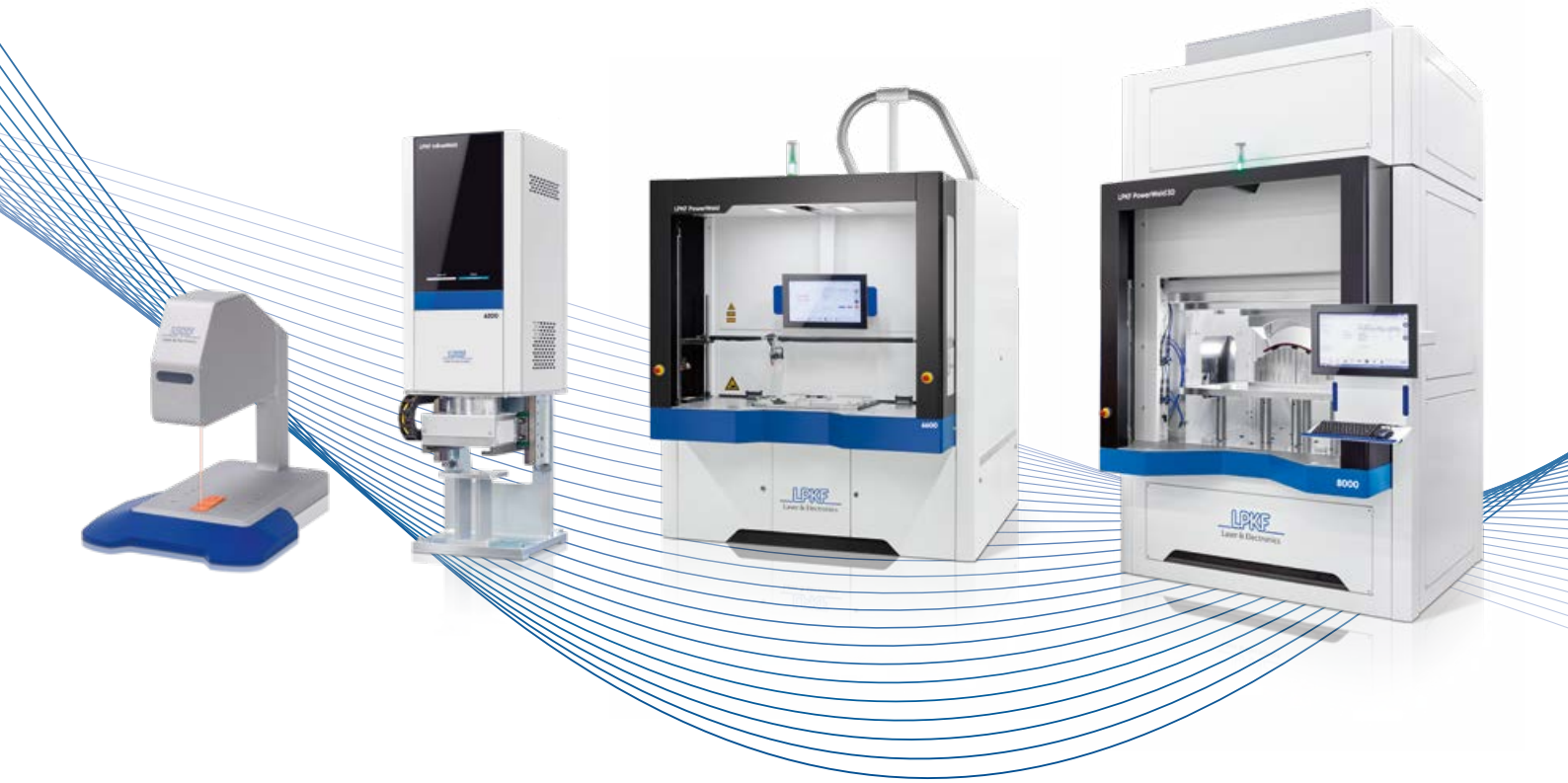
Laser Plastic Welding

The Latest Evolution in Joining Technology from the Leading System Supplier



LPKF
Laser & Electronics

Technology Leader and Pioneer: LPKF Laser & Electronics AG

LPKF Laser & Electronics stands for innovation strength and international presence. Over 40 years of experience in drive and control technologies married to in-depth competence in the industrial application of laser technology. LPKF WeldingQuipment GmbH, a subsidiary of the publicly listed company, specializes in the use of lasers for welding plastic components.

The use of laser plastic welding in industrial applications began with a spin-off from the University of Erlangen-Nuremberg. The company still maintains close contacts with the university's research environment, which is highlighted by its over-proportional involvement in research and development. This creates a positive impact on technique optimization, as well as the discovery of completely new applications.

Binding Solutions

Lasers are becoming increasingly popular for joining two components because the technique is fast, reliable and inexpensive. As the leading supplier of serial production solutions LPKF has much to offer.

Transparent and Absorbent Thermoplastics

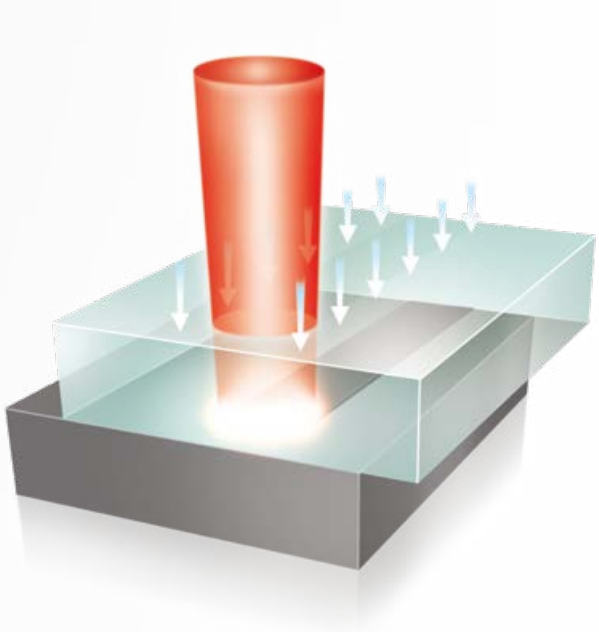
Laser welding relies on two types of polymers, transparent or absorbent. Most thermoplastics in their natural state are transparent at typical laser wavelengths. Additives, such as carbon, in the plastic change the properties so that they become absorbent. The absorbing surface converts the laser energy into heat.

In the transmission laser welding technique, a material transparent to the laser wavelength lies on top of an absorbent material. A clamping tool presses together the parts to be joined. The laser beam penetrates through the transparent component with minor energy loss and melts the surface of the absorbing material. Heat transfers through conduction to plasticize the adjacent surface of the transparent material.

This process is precisely controlled and continuously monitored during laser welding to ensure a repeatable quality weld. After resolidification, the two parts at the joint have been reliably and cohesively bonded.

Reliable Clamping Technology

During laser plastic welding, a defined pressure guarantees the necessary thermal transfer between the two parts being joined. It is therefore essential that the technology works with complete reliability. Uniform clamping is vital for high process quality.



Contents

From Ideas to Products

Narrow laser beams for a glowing future. Modern laser plastic welding boasts numerous benefits and goes well beyond the limits of traditional joining methods. Thanks to its specific advantages, it opens up completely new applications and markets.

New Applications and Material Combinations

High joint quality criteria bring the economic advantages of laser plastic welding into the spotlight. No other method simultaneously combines such a high degree of safety, cleanliness and speed – opening up completely new opportunities!

Laser plastic welding can easily handle complex three-dimensional designs. The beam head itself never touches the material. Even poorly accessible zones or thick layers can be safely joined. Other convincing features are the continuous development of new materials and a wide range of combination options. The process is so gentle, the LPKF WeldingQuipment systems are ideal for components with sensitive surfaces.

Brake fluid reservoir

Economic Advantages:

- Fast product development
- Low total cost of ownership (TCO)
- High flexibility
- Short cycle times
- Simple product solutions

Comparison with Alternative Methods

Laser compared to ultrasonic and vibration welding
- Minor mechanical impact on the components
- No surface damage
- Completely particle-free
- Highest visual quality joint line
- No tool wear and tear, minor tool costs

Laser compared to mirror and hot-gas welding
- Minor thermal stressing of components
- Lower melt overflow
- Much shorter cycle times
- Lower machine and tool costs

Laser compared to hot-melt technology and gluing
- No additives required
- Better options for online process monitoring
- Highest visual quality joint line
- Higher quality and long-term stability
- Shorter cycle times

Application Center for Process Development and Quality Assurance

The results of in-house research, and in-depth practical experience, are made available to a broad circle of users in the LPKF Application Center.

A successful laser welding process begins with the design. Highly qualified engineers help with the process planning; they provide advice on the selection of materials, and determine the best laser parameters. Finally, they jointly work with the clients to develop prototypes and create optimal clamping tools. The Application Center then elaborates quality assurance processes, and trains the operatives. This ensures the economical and uncomplicated operation of this innovative laser joining technology.

LPKF operates a Class ISO 5 clean room for medical technology laser applications. This clean room is used for the production of samples, and for making process optimizations, under the same production conditions used in the medical technology sector.

Optimal Technique – Optimal Result

The key feature of transmission laser welding is transmitting energy through a material. Different approaches can be used. Each method has its own specific strengths; in addition to many shared advantages. LPKF's laser specialists help identify the best method for each application. Their involvement in the production of millions of components gives them the quality experience required for professional consulting.

Contour Welding

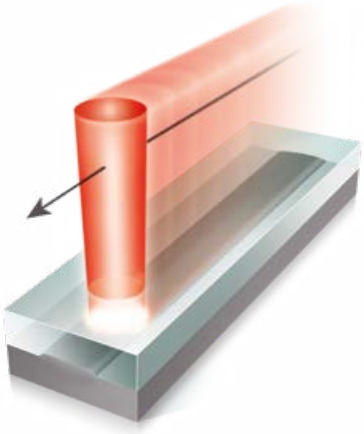
Contour welding is where the laser moves relative to the component. The width of the joint line can vary from a few tenths of a millimeter to several millimeters. Contour welding is particularly good when rotation-symmetrical or very large components need to be welded without any melt overflow.

Simultaneous Welding

Simultaneous welding is where the entire welding seam is heated at the same time. This method requires power density distribution over the radii and changes in height. It is especially recommended for extremely high production runs which justify the large investment required for the special laser equipment.

Quasi-Simultaneous Welding

Quasi-simultaneous welding is a combination of contour and simultaneous welding. A mirror guides a focused laser beam several times along the welding contour at a very high speed so that the entire joint line is effectively heated up and melted simultaneously. Quasisimultaneous welding enables the melt travel to be monitored and compensates for tolerances in the molded parts.



Advantages of Laser Plastic Welding:

- Optional online process monitoring
- Visually high quality weld seam
- Particle-free welding
- Minor stress on the components
- No surface damage

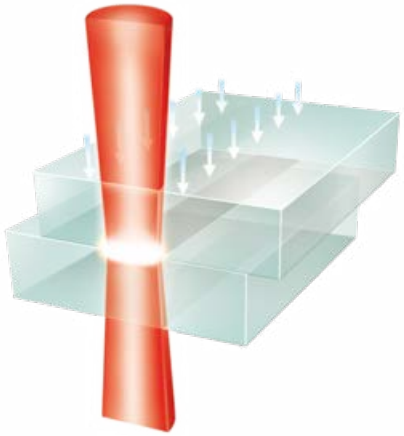
Patented Hybrid Welding

Hybrid welding combines laser energy with infrared thermal radiation from conventional halogen lamps. An air-cushioned roller positioned directly on the joint line applies the required clamping pressure, so that no additional upper clamping tool is needed.

This increases the welding speed whether the components are in two or three-dimensions. The main application for this technology is structural components in the automotive sector, such as: automotive lighting and motor assemblies.

Clear-Clear Joints

ClearJoining technology is the name of a new process developed by LPKF for welding together transparent components without any additives. A laser is focused very precisely onto the joining zone in the transparent material, where it causes localized melting to create a highly reliable weld. A special laser system, a vision system, and the further advanced clamping technology, ensure that this method is always dependable and economic.



More information on these methods is available at **www.lpkf.com**

Benchmark for Laser Welding

Economically efficient laser systems are the product of in-depth experience. LPKF combines applications know-how and consulting competence with successfully tried-and-tested laser welding machines. This brings the users of LPKF laser technology safely to their goal of efficient production.

Objective Advice

Objective advice can only be dispensed by experts having solutions in their product line covering a broad spectrum of applications. LPKF standard systems range from laboratory systems all the way to fully automatic welding cells. LPKF engineers work together with clients to develop customized system concepts for special applications.

All LPKF welding systems are compact and equipped with standard interfaces. They are easy to integrate into existing production environments.

From Laboratory Systems through to Fully Automatic Welding Cells

- LPKF InlineWeld: for integration in client-specific production solutions**
- LPKF PowerWeld: for laboratory applications, small and medium series, as well as large batches*/**
- LPKF TwinWeld3D: for welding large, complex 3D components in a thermal field*
- LPKF PrecisionWeld: for clear-clear joints and microfluidic structures

* range of handling versions available

** different laser configurations available

LPKF – A Strong Partner:

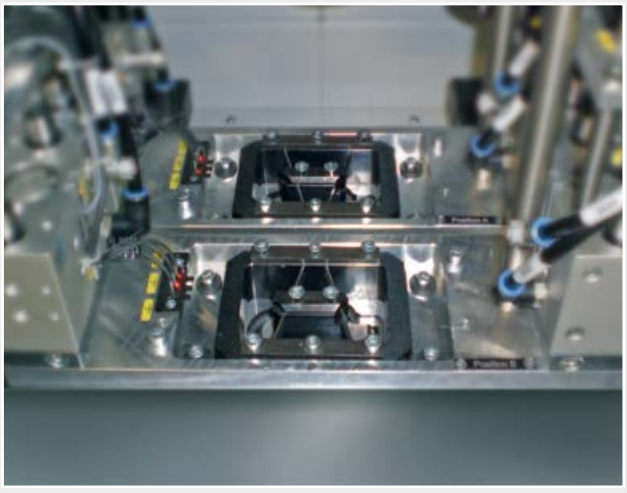
- Guaranteed process capability
- High machine capability
- Comprehensive practical experience
- Intelligent clamping technology
- Laser welding systems for all applications

Easy-to-Use Machine Controls

Two of the key advantages of LPKF welding systems are comprehensive machine capability combined with simple operation. They are equipped with a fail-safe SPC. The remote servicing capability reduces maintenance costs and increases production availability. ProSeT, the standard set-up software, simplifies the programming of welding contours and laser parameters, for a rapid product change.

Quality You Can Rely On

The quality of the final product is determined by the whole process chain. Confirming the process reliability – for each separate component – is becoming an increasingly crucial factor. Production data from LPKF systems can be clearly assigned to individual components. This sets up the seamless background for the specified “tracking & tracing”. LPKF welding systems have also been successfully integrated by clients within Manufacturing Execution Systems (MES).



Holding, Clamping, Feeding

High productivity depends on optimal workpiece loading and feeding. LPKF supplies solutions for every application. The spectrum ranges from manual placement in 2-way rotary tables, to conveyor systems and robot-based feeding systems.

Dual-clamping tools ensure reliable thermal conduction contact within the welding zone. Clamping on both sides of the joint line ensures particularly uniform pressure distribution. The tools can be optionally equipped with air cooling.

Assured Quality

LPKF laser plastic welding is designed to satisfy the highest quality standards in production. It begins with a reliable welding process and continues into the testing phase. LPKF welding systems have integrated process monitoring, including regulation mechanisms which correct even the smallest deviations.

Seamless Control

High quality standards demand seamless control. LPKF welding systems record important process parameters during production, and react to deviations to set values by making automatic corrections or warning the operator. All the data can be easily archived making it ideal for integration within a manufacturing data logging system.

Recording Process Parameters

The successfully tried-and-true melt travel monitoring system gauges the melt travel during laser plastic welding, providing further quality control. Almost all scanner-based LPKF welding systems are equipped with this monitoring method as a standard.

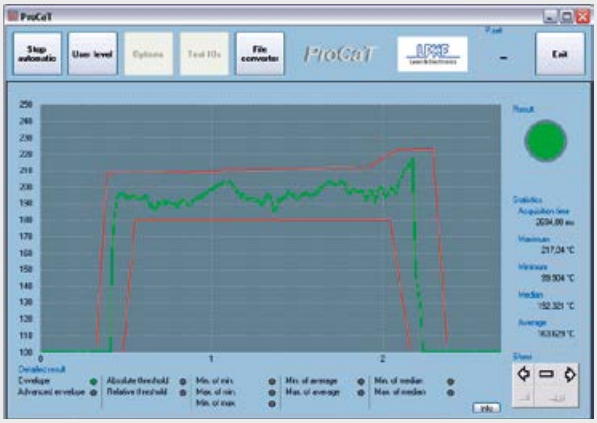
Other methods round off the process monitoring package: a pyrometer measures the temperature in the joining zone to provide information on localized interferences. The burn detection system identifies even the smallest burns on the surface of the components, whilst the vision systems are an option when strongly contrasting materials are used. This range of monitoring systems provides the optimal basis for ISO quality monitoring and documentation.

Stringent Testing to Check Welds

The LPKF testing laboratory has a wide range of methods at its disposal to analyse plastic welds, such as:

- Programmable burst pressure testing up to 7 bar air pressure
- Water bath leak testing up to 7 bar air pressure
- Burst pressure testing up to 40 bar water pressure
- Destructive inspection
- Light microscope evaluation with digital archiving
- Transmission test

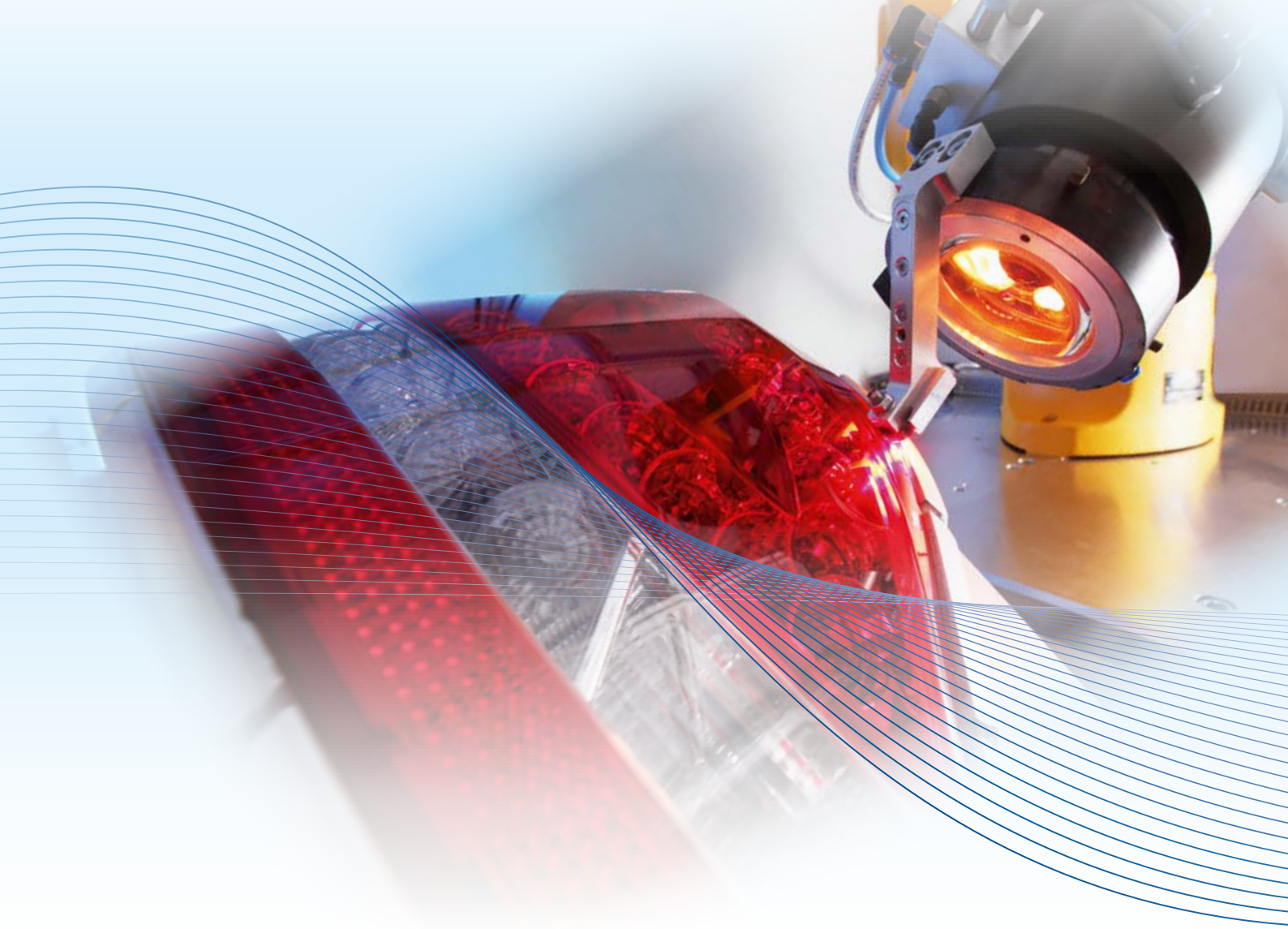
The LPKF Application Center offers feasibility studies during product development, and the opportunity to produce prototypes. The laboratory is also available to its clients for testing batch production.



Pyrometer monitoring allows successful welding to be documented at all times

Material Qualification with LPKF TMG 3

The transmission tester LPKF TMG 3 enables the transparency properties of plastics to be quickly and easily checked and proved. The inline-capable device does the component testing automatically within the welding system. This involves shining light on a component with the same laser wavelength used in the welding process. The transmission parameters are determined within a few seconds and are ready for instant comparison with the original values. Testing reveals any deviations in the materials before an unsuitable component enters the production process.



Automotive Technology in Top Gear

The product quality and production reliability criteria specified by car makers and the automotive subcontracting sector are very high. Laser welding is one of the disciplines which meet the demand of low-cost/high quality requests. Many car makers and models use components economically joined using LPKF laser technology.

Sensor-Electronics for Cars

Modern cars are equipped with numerous sensors to boost passenger comfort and safety. The advantages of laser processing stand out when sensitive electronic assemblies are used in these sensors. Instead of screwing, gluing or pouring sensor housings, they are joined by lasers gently, reliably and economically. Additionally, the entire welding process can be documented for later inspection.

Laser Plastic Welding in the Automotive Sector:

- Traceability / MES integration
- Shortest cycle times
- Low life-cycle costs
- Particle-free processing
- Quality assurance during welding process
- High flexibility

Control Devices for Electronic Steering Systems
Internal electronic components are first fixed in place using laser staking, and the cover is then welded tight to the housing – this can only be done using transmission laser welding.

Control Calve for Lumbar Support System
The tight weld required here can only be performed using the LPKF Dual-Clamping Device (DCD) which simultaneously clamps the outer contours and inner surface of the component.

Complete ABS control-unit for motorcycles

Valve parts – welded and unwelded

Over-pressure/under-pressure unit for car fuel tanks

Fully-integrated transmission control

Medical Technology – Putting People First

When welding seams in the micrometer range are required, there is only one economical solution – laser plastic welding. Other aspects make this joining technique additionally interesting for medical applications, such as: flexible production options, stress-free processing, and hygienic high-precision processing chains – all assuring high quality and profitability.

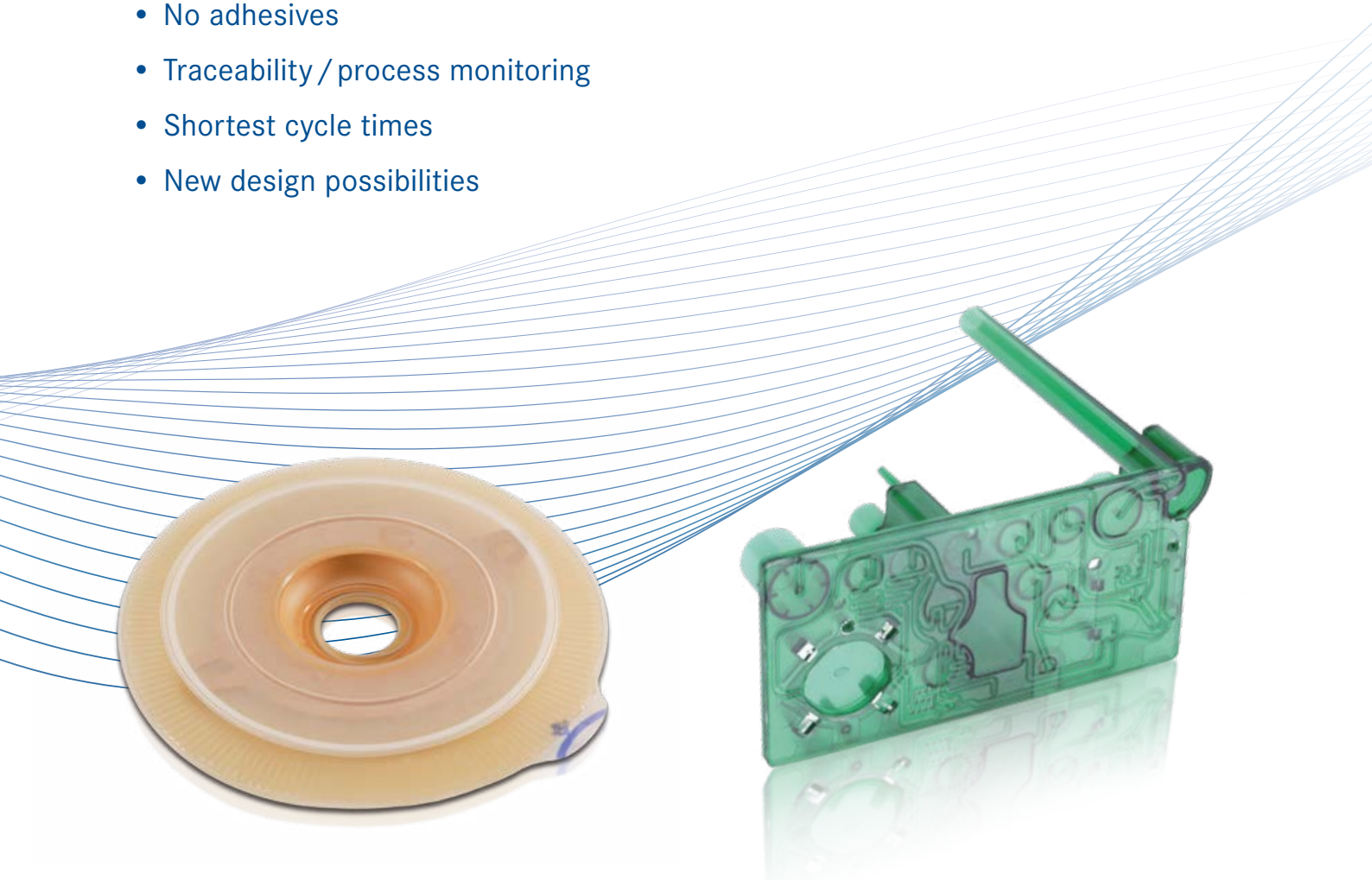
Mini laboratory for complex analysis: thanks to modern microfluidics

Putting people first – this equates to especially high specifications for products and processes. Laser plastic welding scores on both counts. Particle-free processing, different validation methods even during the welding, and clean-room compatibility, are just some of the features highlighting lasers as the tool of choice in the manufacturing of medical products.

An area of application which combines all of these demands is microfluidics. It needs extremely precise joint lines up to several meters long. There must be no contamination by foreign bodies or additives; Creating compelling arguments for laser plastic welding.

LPKF Plastic Welding in the Medical Technology Sector:

- Hygienic energy input
- Particle-free processing
- No adhesives
- Traceability / process monitoring
- Shortest cycle times
- New design possibilities



A Classic Product of Laser Plastic Welding
Ostomy bags of this kind have been mass produced using laser welding for a long time. The joint line is hidden in the interior and satisfies the highest hygiene and quality specifications. Another plus point for laser technology in this application is the minor, easily controllable energy input. Welding machines from the LPKF InlineWeld series are equipped with a pyrometer for online process monitoring.

99 RNA Sensors in an Extremely Compact Unit
This laser-welded microfluidic cartridge is part of a complete, highly specialized mini-laboratory. This opens up a whole new range of opportunities for surgeries and clinics lacking sophisticated laboratory facilities. LPKF was selected to make this product because of the specified two-meter-long joint line, particle-free and additive-free contact surfaces, complete tightness, and guaranteed channel cross-sections.

Microfluidic sensor

PTCA catheter

Micro atomizer

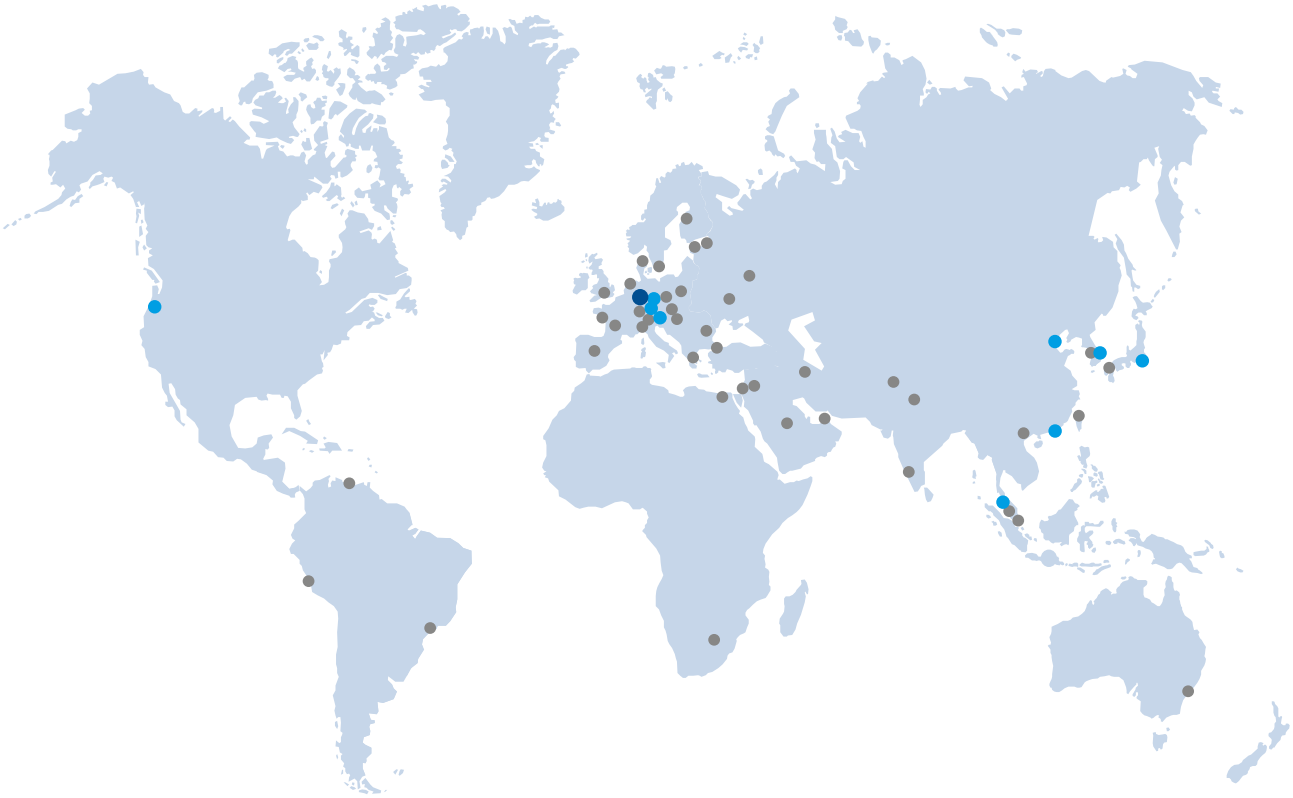
Clear-clear joined wafer

Laser Systems for the World Market

LPKF has been active in laser material processing for many years – with high performance systems for industrial production. LPKF WeldingQuipment combines its own development potential with global mass production experience.

Full Round-the-Clock Service

The clients of LPKF enjoy full round-the-clock service to guarantee optimum availability of their equipment. Service technicians or engineers are available for commissioning the LPKF welding systems and to ensure that production starts smoothly. When the welding systems are running, highly qualified service staff provide professional support via hotlines, remote diagnosis or on-site trouble shooting.



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