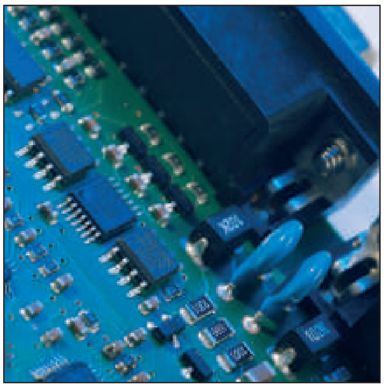
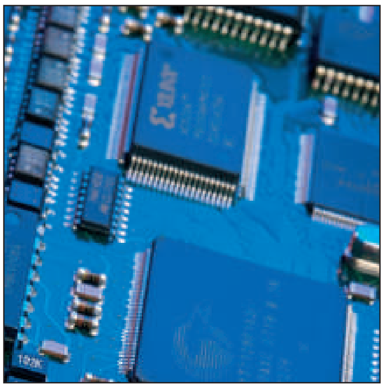
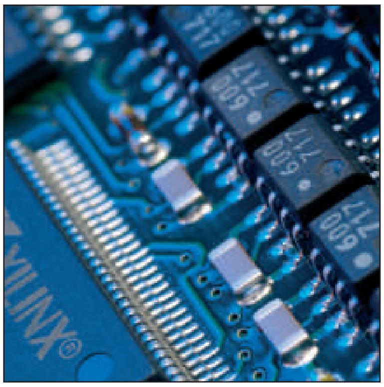
electronics in best hands

COMPLETE SOLUTIONS FOR ELECTRONICS

Inhalt







electronics in best hands

Seidel Elektronik manufactures electronic and mechatronic products on the basis of job contracts and is also an outsourcing partner for services.

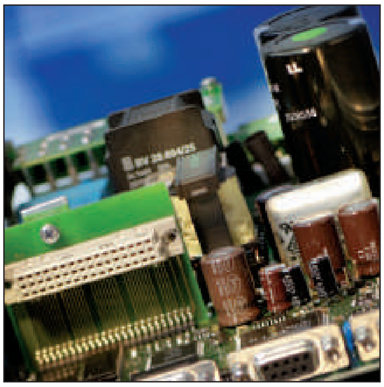
In addition to quality, competence and transparency, dynamic growth and ecological as well as economic sustainability are characteristic features of our company. A workforce of roughly 300 men and women at our location in Deutschlandsberg ensure the permanent satisfaction of our customers with their top performance and high-tech products.

The declared aim of Seidel Elektronik is to find the optimum balance between stable, planned series production and the flexibility demanded by international markets. With its flexible production, comprehensive service and clear customer orientation, Seidel Elektronik has acquired an established position as a high-growth provider of services in the electronics sector. Customer satisfaction as the basis for long-term loyalty is the primary objective in every business relationship. As a result, particular importance is attached to focusing on customers' wishes and needs. Since the respective objectives can take different forms, the customers' wishes and needs must be re-identified for every business relationship and the organization adapted to meet with these wishes and needs.

Developing solutions associated with the use of gas in collaboration with the customer is an essential part of Messer's corporate philosophy. This is the reason underlying the exceedingly successful collaboration between Seidel Elektronik and Messer for many years.

Messer is a leading supplier of industrial gases and gas applications technology. The company's range encompasses all types and grades of gases and services, as well as the supply of gases in cylinders, liquefied gas tanks, pipelines and on-site production, together with the corresponding gas applications technology.

In the electronics sector, it covers the entire process chain from semiconductor production to production of PCBs using gas technology.



Seidel Elektronik: The portfolio

Seidel Elektronik is a systems manufacturer of complex electronic and mechatronic products and devices in large and small series. Systems manufacturer means that the company not only manufactures products in the classical sense, but also offers logistics and engineering services to customers' specifications or arouses customers' interest in these by offering these services.

Co-Engineering

As a circumspect development partner, Seidel Elektronik complements your core competence with individually conceived solutions. Together, we support the development and optimization of your products from the prototype stage to series production.

Our services extend from circuit board design through mechanical engineering design and verification of the design to selection of the components and the development of test and inspection devices. Modern customer-oriented processing is based on clear agreements on the orders placed, jointly defined targets and transparent, reproducible action. You are in good hands here!

Prototype production

You can rely on us as a competent partner in this key phase of the product development process. Optimum conditions for rapid introduction of the products are assured by specification of the components, searching for alternative components, rapidly procuring materials through a worldwide purchasing network and by subsequent production of prototypes. Producing the prototypes under conditions close to those of series production ensures that possibilities for optimization and potential savings can be identified at an early stage to the advantage of the customer.

Cable assembly

We produce customized wiring and control lines to your specifications in small and medium-sized series. Our services range from cutting and crimping through integrally moulding plug connectors to assembly of complete wiring harnesses. With our efficient machinery pool and modern manual workplaces based on the latest ergonomic methods we can offer customized solutions tailored to your specific requirements.

Electronic and mechatronic production

Top quality for your products is guaranteed by the most modern production technology ensuring that the electronic PCBs always comply with the latest state of the art.

In addition, we also have extensive know-how in the assembly of housings and production of precise mechanical devices. Seidel Elektronik can offer products and solutions in the fields of SMD and THT assembly, in-circuit testing, function testing, boundary scan testing, programming, assembly and precision mechanics, as well as run-in, burn-in and climate tests. Over 60% of the products are manufactured as box builds. Good hands work here!

Logistics

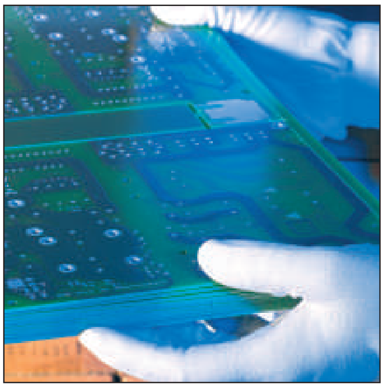
Seidel Elektronik has at its disposal a close-knit logistics network allowing us to procure your components at prices meeting with market requirements even in difficult market conditions. Many hands are constantly working to serve you in our logistics service. All components are purchased from strategic partners, which simultaneously optimizes the costs of transport, storage and handling. Our just-in-time delivery system ensures optimum use of resources. The services offered also include order-picking for direct delivery and complete coordination of your transport logistics. Make use of our logistics centre for additional transhipment to make sure your product arrives in the right place at the right time. We will take care of that!

Services

Service is a matter of great importance at Seidel Elektronik. Our customers, for instance, can keep track of every process at any time during the project via the web browser and online access. Among other things, our „Online Manufacturing Services“ include the provision of a comprehensive component library with thousands of data sheets, access to your technical product data, monitoring of inventory developments, visualization of the order fulfilling process (orders, skeleton contracts) and handling of complaints and/or repair jobs.

Transparency creates confidence and gives you security. In short: **good hands for services!**

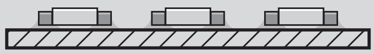
Seidel Elektronik has won the E2MS Award making us electronic manufacturing services provider of the year 2007. The Award is conferred every two years in three classes and confirms that Seidel Elektronik is on the way to becoming the leading provider of electronic manufacturing services (EMS).



Classification of electronic assemblies from the point of view of production

CLASS I Exclusively SMT assembly (one and two-sided)

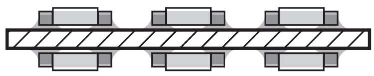
THT & SMD Reflow



THT & SMD Reflow

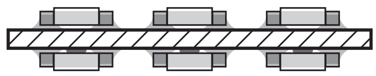
Apply solder paste → Mount SMD → Solder, e.g. reflow

SMT Reflow



SMT Reflow

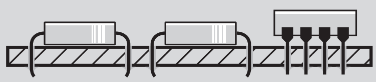
SMT Reflow



SMT bonding

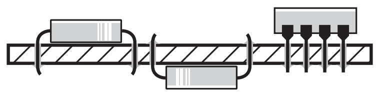
CLASS II Exclusively THT assembly (one and two sided

THT mounted



Mount THT components → Flex and pickle → Wave solder

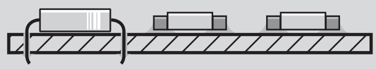
THT mounted



THT mounted – 2nd side partly soldered

CLASS III Combined assembly of SMT and THT components

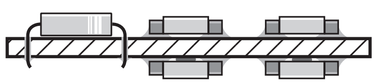
THT & SMD Reflow



Apply solder paste → Mount SMD → Solder, e.g. reflow

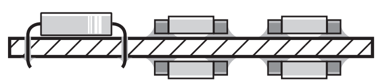
Mount THT components → Flex and pickle → Wave solder

THT & SMT Reflow



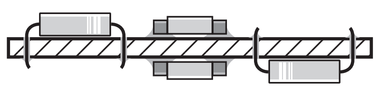
SMT bonding

THT (partial) & SMT Reflow



THT & SMT Reflow

THT (partial) & SMT Reflow



THT (partial) & SMT Reflow

Soldering in practice

Soldering defects and how to avoid them

Increasingly stringent requirements when mounting SMDs and THT components with increasingly small pitch by wave soldering or reflow soldering impose extremely high demands on the soldering process. The average packing density and integration on the PCBs have risen considerably. New component housings with smaller pitch (<0.5), as well as BGA, micro-BGA and flip-chip housings are being used together with the 01005, 0201 and 0402 case sizes. Utmost importance must be attached to process control and process quality. For this reason, the relevant soldering processes must meet with the higher requirements. Soldering defects are not always attributable to the soldering equipment, in fact they are usually caused by many other factors.

Soldering defects can basically be subdivided into three groups:

Component defects: The component pads have oxidized or become soiled by prolonged storage and are therefore difficult to solder with low-activated fluxes (classified in accordance with the standards IPC-J-STD004 and DIN EN 61190-1-1). The pretreatment (tinning, gold-plating, coating with soldering varnish, etc.) may also have been of poor quality or may have been carried out without barrier layer. If in doubt, solderability of the component pads should be checked in accordance with standard IPC-J-STD002 or with a wetting balance. Layer thickness can be assessed with the aid of metallographic sections or X-ray fluorescence measuring systems or simply measured. Ionic residues on the components or circuit board can be investigated and analysed by measurement with a Contaminometer in accordance with IPC-TM650. Material defects in the components cannot always be compensated, even if the soldering process is intact.

Layout defects: An optimum circuit board design is essential for cost-efficient high-quality production. An inappropriate layout can cause numerous problems. High demands to be met with regard to circuit function, EMC, UL, VDE, etc. as well as various standards present new challenges for the development / design engineers. Layout principles are documented in many company standards and often combined with customers' specific requirements. Design guidelines are compiled, for example, in the compendium FED-22-02A. The constantly increasing scale of integration makes it particularly difficult to design a product that is easy to manufacture, optimized with regard to costs and saves energy. Feedback from production, testing, materials management and others is therefore particularly important for development engineers so that these aspects can be taken into account accordingly. Products which are still in the development stage should, as a matter of principle, be produced under series production conditions. Seidel Elektronik provides a feedback instrument in the form of an initial sampling report in which any problems encountered are classified according to production steps, documented and communicated to the customer.

Process defects: These account for the most widely discussed proportion of soldering defects which, however, can be positively influenced by controlling the process accordingly. Fundamental analysis of the individual parameters is decisive in a controlled process. Monitoring and optimization of process steps can be simplified for the process engineer by using modern plant technology with numerous sensors and detailed process data records.

Wave soldering

Flux: The job of fluxes is to remove impurities on the component pads, as well as to activate the surfaces to be soldered and to relieve the tension of the solder wave.

Fluxes are classified according to their activators. The classification of fluxes and their residues is based on the standards IPC-J-STD004 and DIN EN 61190-1-1. Other standards used in the past, such as EN DIN 29454-1 (2.2.3) and DIN 8511 (FSW32) are no longer valid.

Depending on the application in question, flux residues must be removed after soldering. The trend is away from alcohol-based fluxes to water-borne fluxes with low solids content (activator).

Preheating: Preheating activates the flux and at the same heats the circuit board and components in order to avoid excessive temperature shocks for the assemblies in the wave solder. The temperature profile should be adjusted in line with the flux used, the assembly and the solder alloy used. Short or long-wave radiant heaters are normally used for preheating.

Convection heating is usually also used in conjunction with water-borne fluxes and in soldering systems using „lead-free" solder alloys.

Solder wave: The geometry, form, height, intensity, spacing and arrangement of the solder wave have a decisive effect on the soldered result. The type of solder mask, direction of travel of the circuit board and the soldering angle also have a major influence on the final result. Depending on the assembly concerned, a temperature profile should be charted, in which the development of temperature can be followed. Defined process conditions minimizing both the number of defects and the residues can always be assumed if the solder area is inerted by a nitrogen atmosphere. Solder consumption is also significantly reduced due to the elimination of oxidation and dross.

When using „lead-free" solder alloys, use of nitrogen also reduces the surface tension which in turn benefits the flow and wetting properties of the solder. Nitrogen dramatically cuts the operating costs of wave soldering processes.

Man

- Motivation
- Ability and skill
- Quality awareness
- Experience
- Know-how
- State of health
- Work organization
- Communication
- Documents / drawings
- Information
- Time

Machine

- Soldering jig
- Type of fluxer and condition
- Preheating
- Solder wave
- Transport
- Process capability of the machine
- Maintenance / preventive maintenance
- Capacity utilization
- Process gas / residual oxygen
- Operating material
- Process monitoring
- Type of machine
- Documentation

Environment

- Room temperature
- Humidity
- Air pressure
- Climate in the store
- Noise level
- Residual oxygen level in the nitrogen
- Purity of the air
- Component packaging material
- Correct disposal

Material

- Product quality
- Type and quantity of flux
- Solder alloy / impurities
- Contamination of the circuit board
- Base material of the circuit board
- Solderability
- Duration and type of storage
- Surface finish
- Component assembly
- Pretreatment
- Surface condition

Method

- Layout
- Engineering design
- Pitch
- Ergonomics
- Preassembly / preparation
- Type of wave
- Duration of contact with solder wave
- Temperature profile
- Handling
- Cleaning
- Reproducibility
- Solder temperature

WAVE SOLDERING PROCESS

Reflow soldering

In SMD / reflow processes, the result is decisively influenced by the interaction between solder paste, screen or stencil print and reflow soldering.

Solder paste: Solder paste comprises a large number of tiny solder globules (in the micron range) of a specific size and metal composition (alloy) and a flux which is mixed in a certain ratio (90:10 parts by weight). The flux contains alcohol, acids (activators) and stabilizers which are activated to a greater or lesser extent, depending on the application and requirements. These pastes are classified in different groups according to the degree to which their fluxes are activated (see Flux under Wave soldering). Storage of the paste and all processing parameters (squeegee pressure, squeegee speed) and ambient factors (humidity, etc.) are matters of fundamental importance. When producing large series, the solder paste can be processed in closed squeegee systems in order to reduce the loss of solder paste. Automatic replenishment of solder paste from cartridges with the aid of solder paste dispensers is standard practice in open squeegee systems.

Screen print: The solder paste is applied to the circuit board in defined quantities by screen or stencil printing. The relationship between pad size, connecting dimension and amount of solder paste is important here. The depth to which the paste is applied is determined by the thickness of the stencil. Fine-pitch and ultrafine-pitch grids impose high demands on the screen printing machine. The use of so-called multi-stage stencils (stencil sheets of different thickness which are combined into a single stencil) often becomes necessary when combining control and power electronics. Accuracy is vital here in order to obtain a reproducible print. The print produced is usually verified with the aid of a 2D & 3D vision system. Before printing, the position of the circuit board is checked with the aid of register marks (fiducials) and that of the screen with the aid of a camera so that the position can be corrected. Depending on the screen printing machine used, the circuit board is positioned in relation to the stencil or the stencil in relation to the circuit board.

Correction of the position ensures optimum security with regard to print misalignment. The quality of the contour and the geometry of the openings in the stencil, as well as the ratio of thickness to openings, are factors of decisive importance in the stencil.

Man

- Motivation
- Ability and skill
- Quality awareness
- Experience
- Know-how
- Innovation
- State of health
- Work organization
- Communication
- Documents / drawings
- Information
- Control loops
- Time

Machine

Stencil printing
- Stencil thickness
- Design & quality of the stencil
- Process capability
- Semi-automatic / all-automatic machine
- 2D/3D Optical Vision System

Component mounting
- Tolerance
- Process capability
- Speed
- Positioning

Reflow soldering machine
- Forced convection / radiation
- Transport
- Temperature profile
- Residual oxygen level
- Process capability

Environment

- Room temperature
- Humidity
- Air pressure
- Climate in the store
- Noise level
- Residual oxygen level
- ESD
- Lighting
- Purity of the air
- Component packaging material
- Correct disposal

Material

Solder paste
- Solder paste alloy
- Coarseness of the paste
- Viscosity of the paste
- Storage of the paste

Components
- Solderability of the components
- Base material of the circuit board
- Duration and type of storage
- Impurities in the circuit board
- Surface finishing (e.g. HAL, OSP)
- Surface condition

Method

- Layout
- Engineering design
- Pitch
- Ergonomics
- Vision System
- Inspection
- Preheating / temperature profile
- Handling
- Adhesive application
- Mounting principle
- Accuracy
- Software
- Sequences
- Reproducibility

REFLOW SOLDERING PROCESS

Reflow: The term „reflow soldering“ means that the solder material is re-melted for soldering. The most commonly used method is to solder with air streaming over the circuit board by forced convection (nitrogen is also used more and more often). Reflow soldering in radiant ovens is less common: in this case, the circuit board and components are heated by infrared radiation. Condensation soldering (also known as vapour phase soldering) is another method of reflow soldering: in this case, the circuit board is immersed into a blanket of vapour over a boiling liquid. Heat transfer takes place through condensation of the vapour on the cold circuit board and components. The rate of temperature increase is very high with this method.

As a rule, a specific temperature profile is prepared for each assembly. This profile must be adapted to the assembly and the solder paste used. Temperature is measured by means of special temperature measuring instruments (measuring shuttles) on the original circuit board or with a typical dummy. The temperature difference (delta T) on the circuit board is indicative of a reliable solder joint and should be less than 5 °C for a good soldering machine and complex assembly. Low-residue pastes can be used if the assembly is soldered in a nitrogen atmosphere. This makes extensive cleaning processes unnecessary. Soldering under nitrogen presupposes that the residual oxygen level (ROL) is verified in the machine. Increasing miniaturization of the components (chip cases 0201 or 0402) in combination with a very low residual oxygen level – due to the higher wetting capacity of the solder under nitrogen – has resulted in more frequent occurrence of the tombstone effect which, however, is really due to the pads heating up at different rates. More conservative use of the nitrogen or adjustment of the temperature profile can help to remedy the situation here.

Selektives Löten

As a rule, mixed assembly circuit boards with few THT components are soldered partially (selectively). Whether the circuit board is to be selectively soldered and which subsidiary form of selective soldering is to be applied depends on the circuit board design and on the number of circuit boards to be produced. Each subsidiary form of selective soldering basically has its own advantages and disadvantages. The technology available in the company or offered by the service provider should be taken into account when designing and developing a product. Laser soldering is used when circuit boards have to be produced in small numbers or if there are few solder joints on the circuit board. The method‘s essential advantage over manual soldering lies in the precise reproducibility of the process. Mini wave soldering is used when producing circuit boards in numbers exceeding the capacity of a laser soldering system. However, other space requirements must be met by the components to be soldered if this method is to be employed at all. The highest throughput is achieved by dip-fountain soldering.

With this method, all solder joints on the circuit boards are soldered simultaneously with the aid of specially produced solder wave adapters. It is also the method with the highest initial costs for a new product. Thermal stress for the assembly and components can be reduced by use of preheating in the selective soldering machine. Cycle times may also be reduced in this way. The flow properties of the solder can also be influenced by using nitrogen in selective soldering processes with liquid solder in solder pots. The formation of dross due to oxidation and flux consumption are likewise reduced. Moreover, the service life of the selective wave is extended considerably by the use of nitrogen or other inert gases or gas mixtures. Not only does this reduce the required maintenance effort, it also makes series production possible in the first place. For this reason, selective soldering systems are exclusively operated in a nitrogen atmosphere. Great value should also be attached to the materials used for construction of the machinery, for the maintenance work required on the machine increases or decreases considerably, depending on the materials used.

Use of high-grade materials for the solder jets (coated) reduces wear on the solder jets and reduces contamination of the small volume of solder in the pot, as well as on the resultant solder joints.

Man

- Experience
- Motivation
- Information
- Handling
- Ability and skill
- Communication
- State of health
- Work organization
- Correct disposal
- Quality awareness

Machine

- Solder jets
- Standard jets
- Special jets
- Material of the solder jets
- Wettability of the solder jets
- Time for changing solder jets
- Solder jet wear
- Preheating
- Maintenance / cleaning
- Amount of solder in the pot
- Machine documentation
- Reproducibility
- Process capability of the machine
- Cycle time

Material

- Product quality
- Type and amount of flux
- Solder alloy / impurities
- Contamination of the circuit board
- Base material of the circuit board
- Solderability
- Duration and type of storage
- Surface finishing
- Component make-up
- Pretreatment
- Surface condition

SELECTIVE SOLDERING

Method

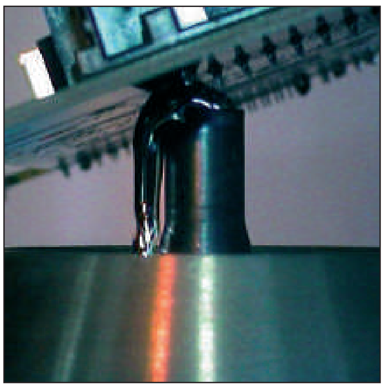
- Induction soldering
- Mini wave soldering
- Laser soldering
- Dip-fountain soldering
- Through-hole soldering
- Assembly aligned with jet
- Assembly in any position
- Residual oxygen level
- Solder temperature
- One-side solder flow
- Directed solder flow
- Component preparation
- Preassembly
- Temperature profile
- Transport system
- Layout
- Spaces around solder joint
- Pitch
- Component positioning
- Process documentation

Environment

- Series production
- Mixed production of several products
- Capacity utilization
- Storage conditions

Climatic conditions in production

- Noise level
- Purity of the air



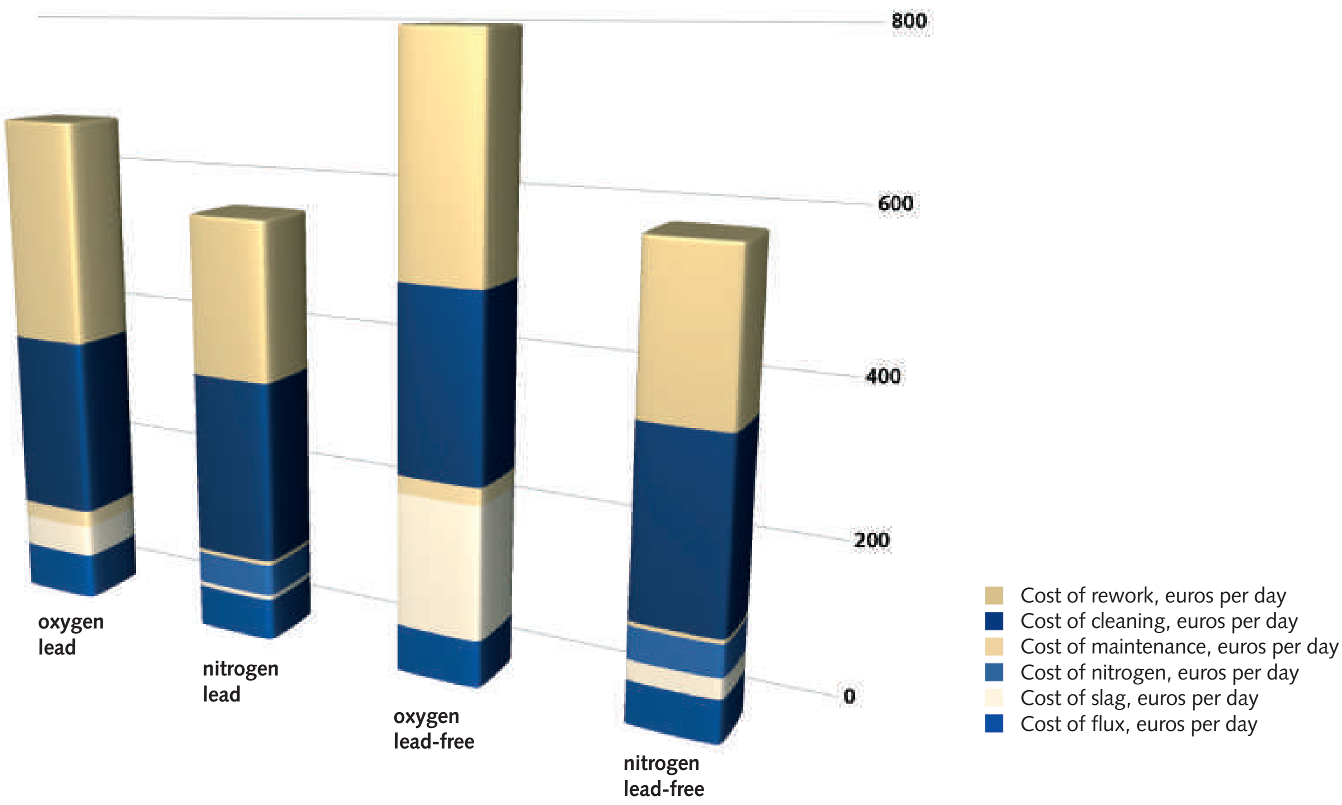
Feasibility analysis of soldering under inert gas

Soldering under nitrogen may appear uneconomical at first glance if the costs for the soldering process are considered in isolation.

A closer look with inclusion of the costs for rework, however, very quickly shows that soldering under a nitrogen atmosphere can also yield cost advantages when using lead solders.

Use of nitrogen has an impact on the following aspects:

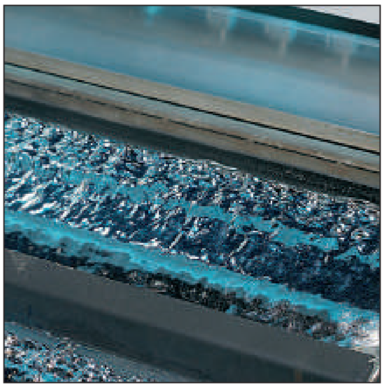
- Reduction in remaining residues, visually clean circuit boards
- Less rework due to changed flow properties
- Fewer contact problems in the ICT and FAT test
- Better wetting and improved through-hole properties
- Higher solder quality
- Flux and solvent consumption are minimized
- Less machine maintenance and therefore better utilization of machine capacity
- Fewer bridges in the reflow area due to lower surface tension of the solder
- Larger process window (processing different products with the same process parameters and equally good quality)

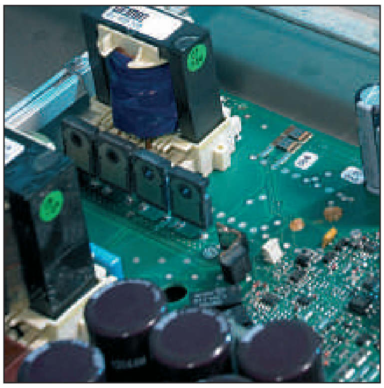


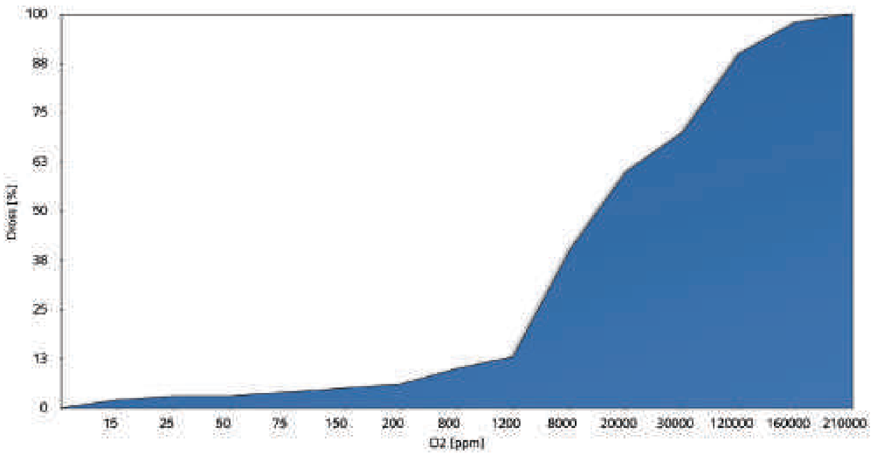
Taking into account the changes in the wave soldering process due to the use of nitrogen, the resultant feasibility analysis tends to favour nitrogen.

The use of nitrogen can only be justified by a very large reduction in the cost of rework due to the use of nitrogen. A completely different picture arises when the technological changeover to lead-free production is included in the feasibility analysis. Such a situation is illustrated in the diagram. It shows very clearly that it less expensive to prevent oxidation of the expensive lead-free solder by using nitrogen. Removing the metal oxides (slag) and the associated use of new solder material are very much more expensive than the use of nitrogen.

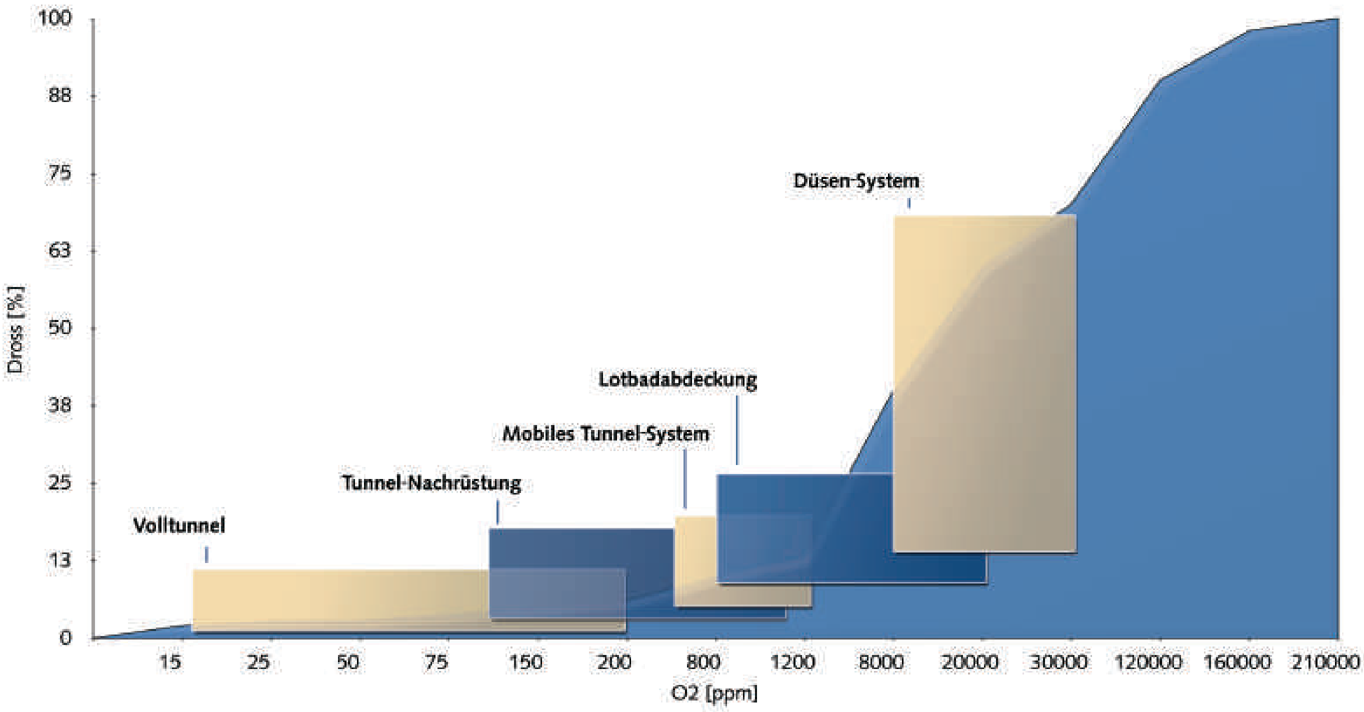
Depending on the application concerned, the most advantageous overall method should be selected for the product with consideration of all influences and consequences. The most important aspects of using gas in the production of printed circuit boards are discussed below. Soldering under inert gas has become increasingly more important in recent years and is now largely accepted as being state of the art. Despite this, however, there are a number of points to be taken into account in practice: the correct residual oxygen level in the soldering atmosphere is therefore a very important aspect on account of the associated economic implications.







Wave soldering under nitrogen



Wave soldering systems can be inerted in a variety of ways. A distinction is generally made between three of these.

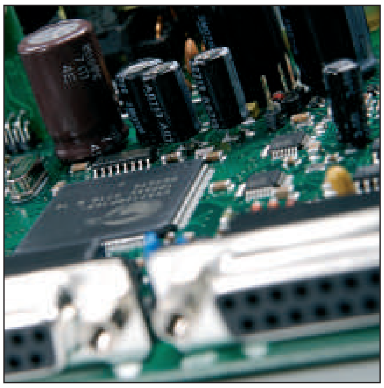
For one thing, virtually every manufacturer today offers systems which are prepared from the outset for operation with nitrogen. In the majority of cases, the distance travelled by the assemblies is completely enclosed by a tunnel separating it from the outside world. Typical residual oxygen levels (ROL) between 20 and 400 ppm can be economically obtained in this way. All the advantages mentioned in conjunction with the use of nitrogen can be utilized by fully encapsulated systems with curtains or flaps at both the entry and the exit. Wetting properties and thus also the solder quality can be influenced in particular by adjusting the ROL value within the system. For companies with a large product spectrum and little opportunity of influencing the layout, this use of the process parameter „soldering atmosphere“ is a factor of immense importance. In addition, short tunnels or solder bath covers are often retrofitted on existing systems. Both types of retrofit rely on the covering effect due to the circuit board and the enclosing mask. The possibilities available for inerting wave soldering systems are summarized in the table and diagram.

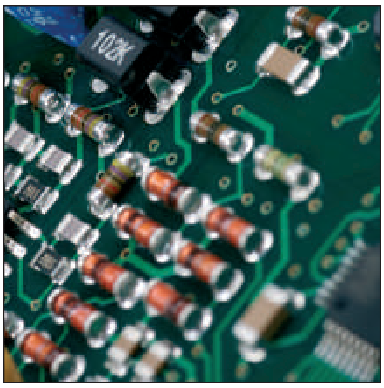
System	Investment	Dross reduction	Defect reduction	Nitrogen consumption
Full system	Very high, approx. EUR 40,000	Very high, over 95%	Very high	High to very high, 15 to 45 m³/h
Tunnel	High, approx. EUR 20,000	High, approx. 80 to 85%	High	High, 12 to 18 m³/h
Solder bath cover + MTS	Medium, approx. EUR 7,000	High, approx. 70 to 90%	Medium	Medium, 8 to 12 m³/h
Solder bath cover	Medium, approx. EUR 6,000	Medium, approx. 60 to 80%	Medium	Medium, 6 to 10 m³/h
Nozzle systems	Low, approx. EUR 4,000	Low, approx. 40 to 70%	Low	Low, 4 to 8 m³/h

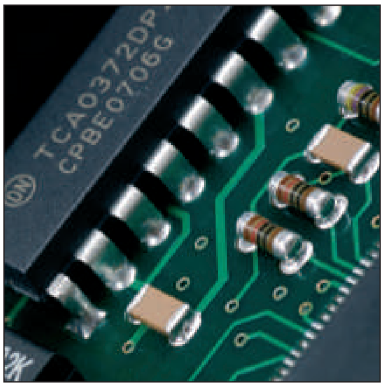
Messer supplies retrofit kits in the form of tunnels or solder bath covers. Almost all the advantages of a nitrogen atmosphere can be utilized in this way. The solution chosen in a specific case depends on the objective to be achieved in each case. To a large extent, however, the decision depends on the savings resulting from the dross reduction achieved by the selected investment. This no doubt gives rise to the question whether the higher investment cost of a full-tunnel system cannot be compensated by the lower cost of dross. Messer offers a feasibility analysis in collaboration with the customer and based on our know-how.

What effect does inerting have on the wave soldering process?

Nitrogen essentially prevents rapid oxidation of the liquid metals. As a rule of thumb, the oxidation rate doubles with every 10 K rise in temperature. Inerting makes aggressive fluxes and cleaning stages unnecessary. Modern inert gas wave soldering systems, such as those supplied by Seho, represent a new generation of machines combining all aspects of modern production. Complex soldering tasks can be realized by operating selective soldering machines with inert gas. Using nitrogen for wave soldering also yields other advantages: the absence of oxide on the wave surface ensures that formation of the solder joint is not impeded in any way at all. The flux that is normally required to reduce the metal oxides is no longer needed, resulting in lower consumption. In addition to saving material, the bath life is extended as the pot area need only be cleaned occasionally. Since toxic lead oxide particles often escape into the production hall during the cleaning process, inerting the wave soldering process is also advantageous from the point of view of occupational safety. In recent years, the solder defect rate has been intensively investigated as a function of the set soldering atmosphere (residual oxygen level). Whether the defect rate in a particular process is actually influenced by the use of nitrogen depends on many different parameters, but it can safely be assumed that a poorly controlled process will not necessarily be improved by the use of nitrogen. All in all, the number of defects attributable to wetting problems will be considerably lower. When all relevant parameters are considered (layout, temperature profile, …), defect rates can be reduced considerably by wave soldering under nitrogen.

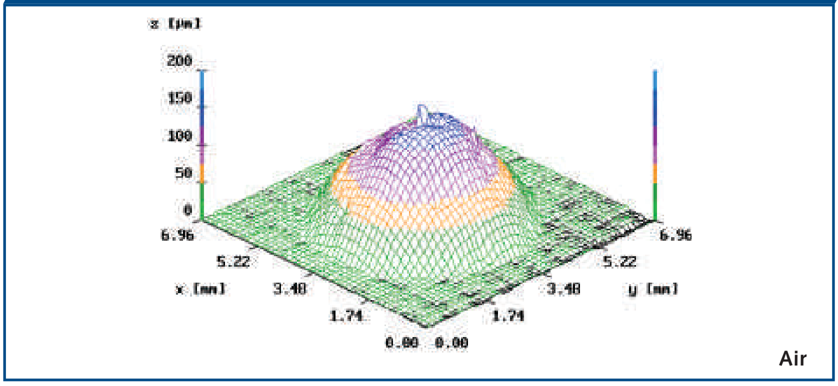






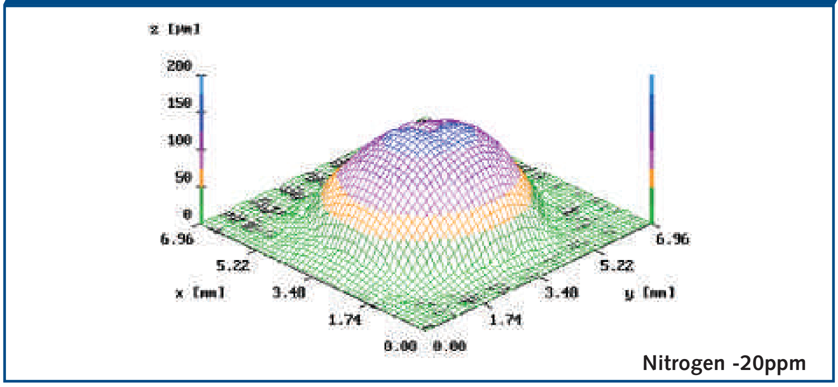
The reason for this lies in the better wetting properties due to the lower surface tension of the liquid alloys in a nitrogen atmosphere. Particularly in conjunction with the use of lead-free materials, this advantage of using nitrogen is becoming increasingly important, for the considerably poorer wetting properties of lead-free solders as compared with modern technology can be significantly improved in this way. Another point that is often mentioned in conjunction with the use of nitrogen is the „larger process window", meaning that component and circuit board variations no longer have such an impact on the soldered result. Two ranges are usually set for the residual oxygen level when wave soldering under nitrogen: as the diagram shows, values around 1,000 ppm will suffice if attention focuses primarily on reducing the formation of dross. This is where the use of retrofit systems, tunnels and solder bath covers is both possible and advantageous. However, values between 100 and 500 ppm are set if all advantages are to be exploited. Although such ROL values can also be achieved with retrofit systems, the use of a full system should be intensively investigated in such cases. Only processes with absolutely no cleaning and very high requirements are operated with less than 100 ppm; here too, the decisive factor is to reduce the number of solder defects. Depending on the type of defect involved, the higher wetting force can be used to reduce the defect rate. Nitrogen consumption naturally depends on the selected inerting method, machine capacity utilization (oxygen deprivation) and the set ROL. The diagram shows corresponding consumption levels for typical cases.

AIR **Large wetting angles**



Air

NITROGEN **SMALL WETTING ANGLE**



Nitrogen -20ppm

CAUSES: • Oxidation of the solder • Oxidation of the metal surface • Differences in spreading and wetting action

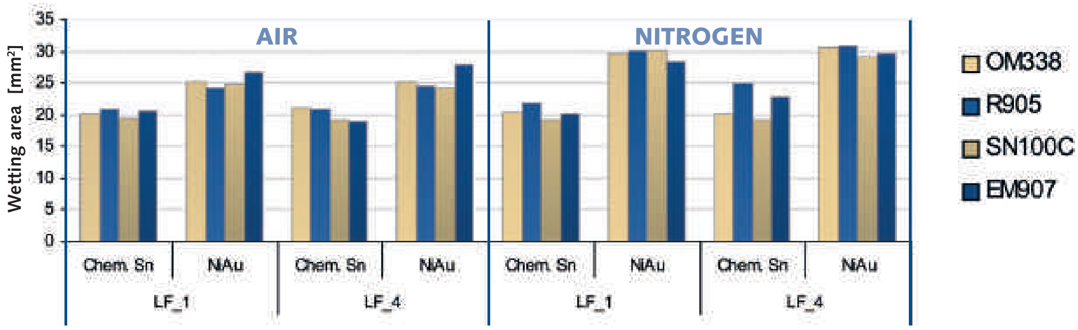
Measurement of the residual oxygen level

In the majority of cases, the residual oxygen level is measured with the aid of an electrochemical or zirconium oxide cell. The test gas is pumped through a set of filters designed to remove the remaining solder vapours. It is often difficult in practice to establish whether the filters are already saturated and the measuring cell blinded by residues. The value indicated by the instrument is therefore not particularly reliable. Flux residues also accumulate in the measuring line in many cases and can significantly restrict the rate of flow with time. Since measuring lines are often fairly long, the instruments only show an average value over time. As a result, very high, barely detectable residual oxygen levels can arise at precisely the moment at which a circuit board is being wetted with solder as it passes through the system. Messer supplies a large range of measuring instruments with the corresponding know-how for measuring ROL values here. In addition to know-how in measurement and filter technology, this also includes knowing „where“ and „how“ to carry out the measurements. In particular, long-term measurements are plotted in order to obtain a reproducible picture of the system. In most cases, the problems arising with customers‘ measuring instruments can be permanently solved with the relevant gas know-how (special built-in fittings, such as filter attachments, automatic calibration devices, etc.). If this is too complex, the instruments can be tested on site with calibration gases or cross-tested with a suitable instrument.

Reflow soldering under nitrogen

In reflow soldering, nitrogen is used above all when no-clean pastes, OSP or fine-pitch components are involved. The advantages here are the same as in wave soldering. Solder defects due to wetting are considerably reduced by the inert atmosphere. Nitrogen is frequently recommended for certain surfaces, such as NiPd or OSP. The conditions under which the solder paste is reflowed have a decisive impact on the quality of the solder joint and frequency of solder defects. The soldered result depends decisively on the residual oxygen level of the oven atmosphere.

Residual oxygen levels of roughly 1% lead to a significant reduction in defect rates (see above) when using RMA pastes. However, residual oxygen levels between 50 ppm and 900 ppm should be set if particularly stringent requirements must be met (no-clean, VLR pastes). The precise value depends on the selected paste system, among other things.



Tailormade gas supply

Producing nitrogen by cryogenic rectification has been the predominant process ever since the turn of the century. The resultant nitrogen is of high purity and is either filled into gas cylinders or tanks or pumped through pipelines to the point of use in liquid form.

Today, however, a number of non-cryogenic separating processes are also used, such as pressure swing adsorption and membrane techniques. Under certain conditions, these processes are an economic alternative to the traditional supply of liquid nitrogen. Since the optimum type of supply depends on a large number of factors, sound advice is essential in all cases. Messer advocates on-site production of nitrogen wherever appropriate for the user. Messer already operates numerous such plants in Europe and Asia. In-house development work and cooperation agreements with plant manufacturers ensure that the most efficient technology is used in each case. The following are the most important factors influencing the choice of supply:

- Peak and average demand
- Required gas purity
- Demand profile and plant capacity utilization
- Additional use of cryogenic refrigeration
- Energy consumption
- Availability of compressed air

The following are a few typical examples of use in conjunction with the production of electronic assemblies:

1) Large-scale consumption in multi-shift operation > 250 Nm³/h: on-site generators can be operated cost-efficiently in such cases. The purity of the nitrogen produced is in the ppm range.

2) Normal operating condition of reflow wave and selective soldering systems: the ROL value of the soldering atmosphere lies between 20 and max. 900 ppm. Nitrogen is supplied from a liquid nitrogen installation and has a maximum ROL concentration of 10 ppm. All data on nitrogen consumption by the plants are based on a purity of max. 10 ppm. Nitrogen consumption increases accordingly when using plants with higher ROL value.

3) Special case: BGA rework station. Since the process conditions for repairing BGAs make nitrogen necessary, such rework stations are frequently supplied with bottled gas. The associated handling of gas cylinders entails considerable effort. A small membrane installation supplies nitrogen of adequate quality and can be switched on and off without difficulty when required.

Method	Physical separation principle	ROL/ppm
Generator	Small cryogenic air separation plant (single-column apparatus, cryogenic rectification)	< 5 ppm
PSA	Air separation system based on the principle of pressure swing adsorption (PSA)	< 1000 ppm
Membrane technique	Air separation by selective permeation through thin polymer membranes	approx. 0,5 %

Gas service

Use of gases is supported by customer-oriented departments: Messer has installed a team to support the production of circuit board assemblies with a range of services going far beyond the mere supply of gas. In collaboration with leading manufacturers in the electronics industry, we have developed gas application technologies covering the entire process chain from semiconductor production to production of assemblies.

The use of gases in electronics, such as nitrogen for soldering as described above, has been state of the art for a long time. Messer offers a comprehensive package of technology and services for the electronics industry:

Cost-efficiency

Every process is preceded by a detailed investigation of cost-efficiency. Among other things, this includes selection of a suitable soldering atmosphere (residual oxygen level) and consequently minimization of the gas consumption. In addition, Messer also advises customers when selecting the most appropriate gas supply concept (e.g. local nitrogen production or supply of liquefied gas). Where necessary, tests are carried out on site to establish the optimum process window.

Investigation of soldering processes

Problems may naturally still arise in production despite all efforts to the contrary. Messer offers analytical services here, in collaboration with acknowledged experts. Assemblies and soldering processes are investigated together with the Fraunhofer Institute for Silicone Technology (ISIT) in Itzehoe. The experts can also help to optimize processes directly on site. In addition, circuit board and component surfaces can be analysed using a whole variety of ultramodern measurement methods. Metallographic sections are appraised under conventional microscopes (light and scanning electron microscopes), surface deposits (e.g. contamination or oxidation) reliably assayed with AES or mechanical surface properties measured with an AFM (atomic force microscope).

Development projects

In addition to providing numerous services, our development department is also focusing above all on the changeover to „lead-free" technology in circuit board production. Numerous cooperation projects with leading partners and customers have been initiated in this context.
Practical implementation of our employees' technological know-how and making use of the insights resulting from our basic research are focal aspects in these projects. Surface tension and the wetting properties of lead-free solder material in an inert gas atmosphere with different residual oxygen levels are aspects of particular interest. For the manufacturer of printed circuit board assemblies, these data provide an important basis for selecting tomorrow's solder material.

A small selection of our activities shows

that working out solutions together with our customers is an essential element of our corporate philosophy. We offer our customers individual solutions meeting their needs and based on our know-how, as well as that of our cooperation partners and independent institutes. Contact us if you too would like to profit from that know-how!

SEIDEL Elektronik
GmbH Nfg. KG

Frauentalerstraße 100
A-8530 Deutschlandsberg

Tel.: +43 3462 6800 – 0
Fax: +43 3462 6800 – 165

E-mail: office@seidel.at
www.seidel.at

Messer Group GmbH
Technologie Management Industrie

Gahlingspfad 31
D-47803 Krefeld

Tel: +49 2151 7811 – 228
Fax: +49 2151 7811 – 503

E-mail: info@messergroup.com
www.messergroup.com

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