

THERMAL SYSTEMS

# Top performance with or without vacuum

Reflow condensation soldering for multi-faceted areas of application



CondensoX-Series  
Condensation Soldering

# Condensation Soldering

Reliable and flexible!



## Reflow soldering by condensation Multi-faceted processes with the CondensoX

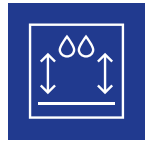
**The reflow soldering field of industry is wide-ranging, whether it's in aerospace engineering, LED manufacture or power electronics. Electronic components only work in end devices by soldering electronic contacts in a high-quality fashion. But what happens when components on the circuit board are very large or high-mass? Or if vacuum soldering processes should be implemented inline?**

In condensation reflow soldering, or vapour-phase soldering, soldering is accomplished using a hot vapour. To put it in simpler terms: Imagine you have just come from the ski slope and walk into a warm chalet with cold ski goggles. The goggles fog up instantly. This is called film condensation. You can only see clearly again once the ski goggles have reached room temperature. Condensation soldering works based on the same principle.


In this case, heat transfer in condensation soldering is up to ten times higher than with convection soldering. This means that even large, high-mass boards can be reliably processed in a stable atmosphere and with innovative vacuum technology with Rehm's CondensoX-Series.

# The CondensoX-Series at a glance

## Flexible and adjustable



Do you process large and heavy boards for which condensation soldering is out of the question? Or do you want a system that you can reliably carry out vacuum processes with at any time? Then choose a CondensoX-Series system that can be customised to your manufacturing environment!



XC

**CondensoXC**  
Space-saving and powerful

- › Batch system for low throughput
- › Used in laboratory applications, small production lines or prototyping



XS

**CondensoXS**  
Great performance with a small footprint

- › Batch system for medium throughput
- › Low space requirements
- › Ideal for small-series production



XM

**CondensoXM**  
All-rounder for electronics production

- › Batch system for medium throughput
- › Extended transport axis
- › Used for small and medium-sized series



XP

**CondensoXP**  
Ideal for large series

- › Inline connection for medium throughput
- › Manual/automat. loading with an axis
- › Used in series production



XP  
HS

**CondensoXP HS**  
Quick and efficient manufacturing

- › Inline connection for high throughput
- › Two loading axes for more efficiency
- › Used in high-speed areas



X-  
Line

**CondensoX-Line**  
Reliable in the through-feed process

- › Inline system for high throughput
- › 3-chamber system and built-in vacuum soldering
- › Series manufacture and power electronics

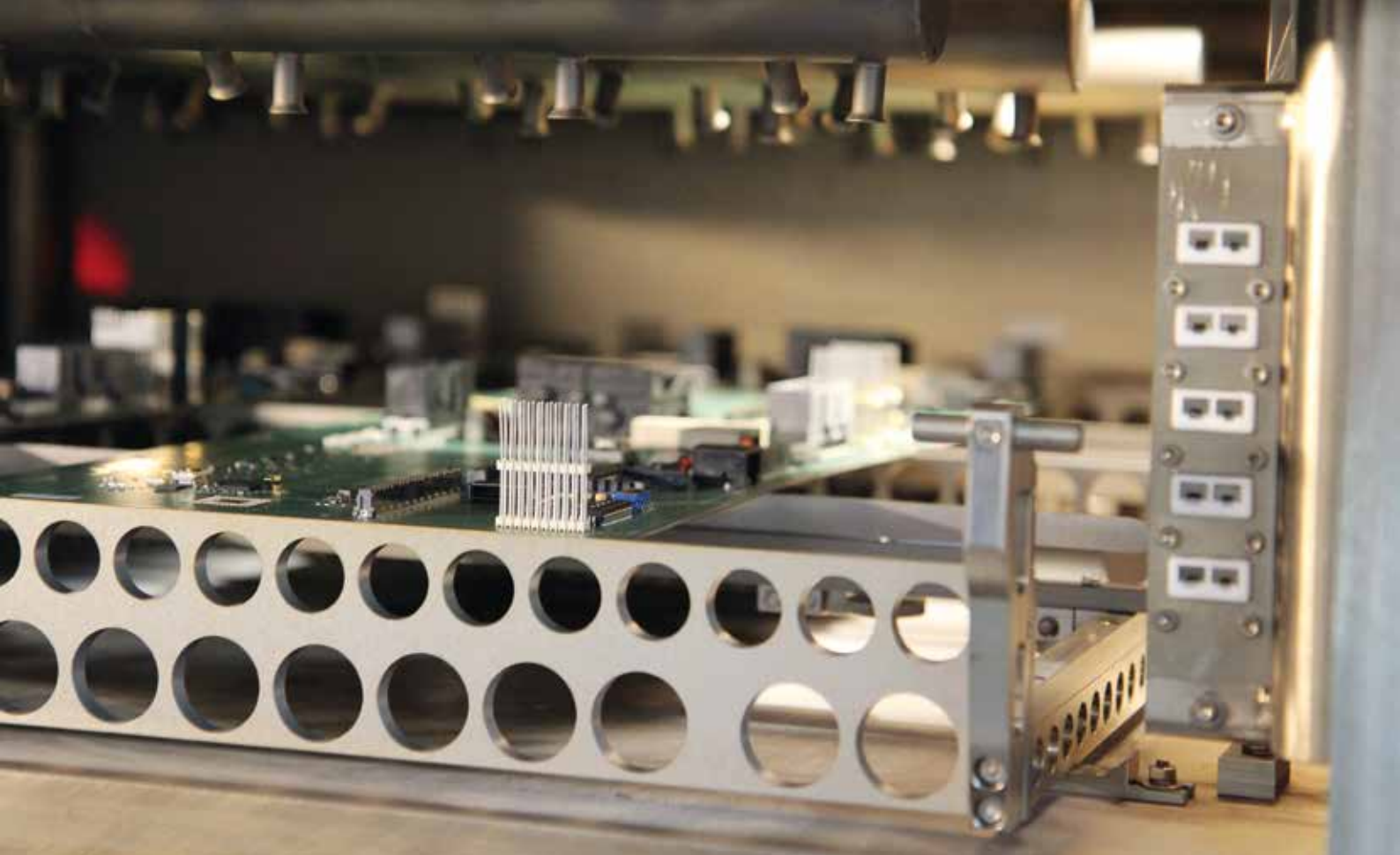
# Vapour phase soldering in every manufacturing environment

The CondensoX-Series system versions can be integrated into a wide range of manufacturing environments. Whether it's a batch operation, inline connection or continuous soldering – Rehm offers the highest degree of process reliability for all areas!

The application options for the CondensoX-Series are as varied as their production. We would be happy to determine the most efficient system for your manufacturing process, taking all relevant processes such as throughput, assembly size, thermal mass and follow-up processes into account.



- › Patented injection principle – reproducible reflow profile
- › Hermetically sealed process chamber
- › Controllable vacuum process – Pre-vacuuming und vacuum feasible after soldering
- › No Galden® spreading, active Galden® filtering
- › Process monitoring with a wireless WPS system (only with CondensoXS, XM, XP and XP HS)



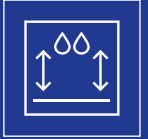
## Condensox – a patented principle with clear advantages

**With the Condensox-Series, a far greater amount of flexibility is available for the condensation soldering process than can be achieved with the conventional method. Using the injection principle and temperature and pressure (vacuum) control ensure more accurate and versatile reflow profiling.**

The soldering process takes place in a hermetically sealed process chamber. A film of fluid builds up during condensation soldering using the heat-conducting medium Galden®, which surrounds and vaporises the entire assembly. The steam condenses on the assembly until a soldering temperature of 240 – 260 °C is achieved. Galden® is a perfluoropolyether – fluid polymers that consist of carbon, fluoride and oxygen. Rehm applies a patented injection principle to improve

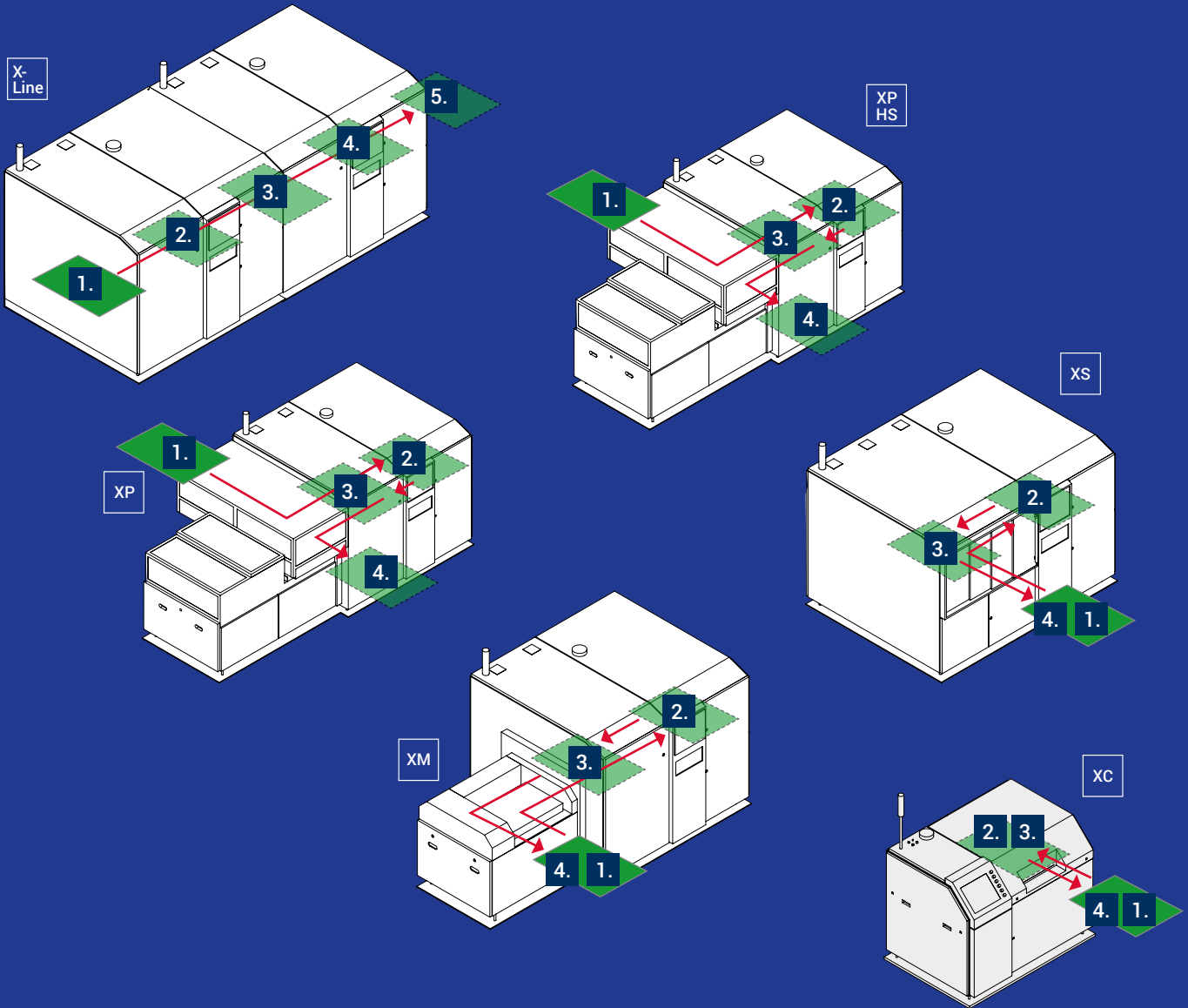
control of the condensation phase. Exactly the right amount of Galden® is incorporated at the right time. Then, during this process, redundant, latent heat is used when changing the state of the medium from vaporous to fluid to evenly and steadily heat the assembly. The max. temperature of the assembly cannot exceed the max. boiling/condensation temperature of the medium to ensure the components don't overheat.

The temperature/reflow profile of the assembly can also be accurately adjusted by precise fluid volume control and intermediate steam extraction. Therefore, reproducible soldering conditions are ensured that increase process stability. A vacuum option is available with all Condensox for optimum results that are virtually void-free.



# Six machines, one process

## CondensoX chamber systems



- 1. Loading
- 2. Pre-chamber/Pre-inerting
- 3. Soldering/Vacuum
- 4. Cooling
- 5. Unloading



- 1. Loading
- 2. Soldering/Vacuum
- 3. Cooling
- 4. Unloading

# Accurate profiling capability

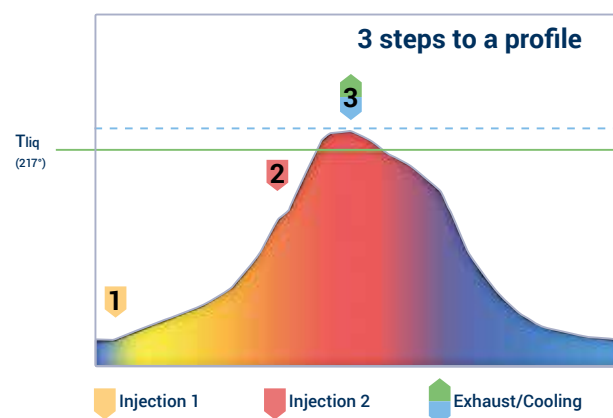
## 3 steps to a profile – 5 steps with vacuum

### Only 3 steps to a profile



This makes profiling simple! With the Rehm CondensoX-Series, you only need three steps to create an optimum profile for your assembly. What's more, the possibilities are endless for further refining and adjusting your profile, depending on your requirements. However, the following steps are usually enough to reach the optimum temperature profile for your application:

1. Injection of the Galden® | Pre-heating of the PCB
2. Injection of the Galden® | Ideal soldering temperature
3. Exhaust of Galden® | Cooling

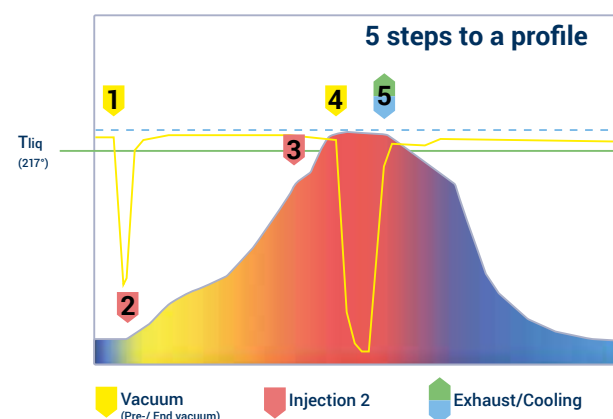


### 5 steps with vacuum



A pre-vacuum doesn't just allow the Galden® steam to be evenly injected, it also enables solvents and moisture to be de-gassed from the solder paste. After the max. soldering temperature has been reached, the gases that are still present can escape from the solder paste more easily using an end vacuum. Surface binding of up to 99 % occurs as a result.

1. Pre-vacuum | Uniform distribution of the Galden®
2. Injection of the Galden® | Pre-heating of the PCB
3. Injection of the Galden® | Ideal soldering temperature
4. Vacuum during the melting phase | Void-free solder joint
5. Exhaust of the Galden® | Cooling



# Safe transport – flexible handling

## Adapted to batch size and cycle time

With the CondensoX-Series, the assembly moves horizontally through the system with the exception of the CondensoX, where the workpiece carrier is lowered vertically due to lack of space. The circuit board stays still in all systems during the process, and so the components don't slide in the melted stage. The handling systems can also be adjusted later on. By changing the loading systems, you can obtain an optimum production workload depending on your manufacturing requirements.

### Manual front loading/unloading



CondensoXC and CondensoXS are manually loaded and unloaded from the front. To do this with the CondensoXC, the operator places the workpiece carrier at the front on the process chamber bulk-head using a rail system. With the CondensoXS, the workpiece carrier is suspended under the cooling system. To do this, it can just be extended on a separate axle to the loading door for loading and unloading. The workpiece carrier can be completely changed or loaded and unloaded in its suspended state. Max. soldering material dimensions are 500 x 500 x 80 mm for CondensoXC and 650 x 650 x 95 mm for CondensoXS.

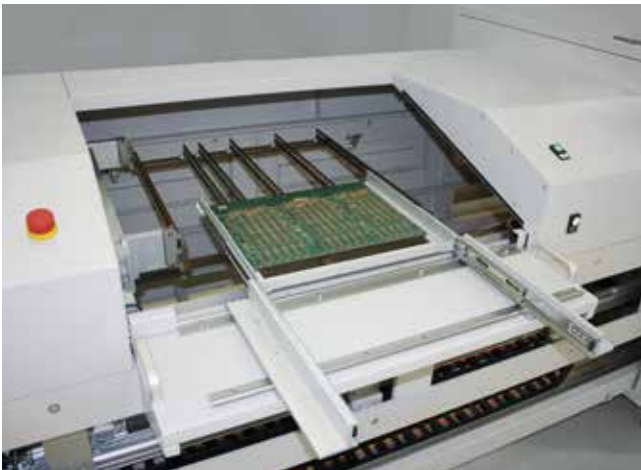


Changing the workpiece carrier with the CondensoXS



Inserting the workpiece carrier into the CondensoXC process chamber

### Manual loading/unloading on an extended transport axis



Changing the workpiece carrier with the CondensoXM

The CondensoXM is loaded and unloaded manually outside the system. To do this, the workpiece carrier travels to the loading/unloading area on an extended transport axis. The operator can conveniently insert or remove the workpiece carrier. This is especially helpful for large and heavy assemblies. Max. soldering material dimensions are 650 x 650 x 95 mm. The workpiece carrier can be completely changed or loaded and unloaded in its suspended state. A light grid protects the transport axis in the event of interference, and therefore protects the operator.



## Automatic loading/unloading for large series



With the CondensoXP, the loading axis is designed in such a way that it is suitable for connection to a load handling system. Therefore, it can be manually and automatically loaded or unloaded with an axis. The CondensoXP HS has a second loading axis for an even higher throughput, e.g. when processing large series or in the high-speed area. The process chamber can be refitted with the first axis while the workpiece carrier is cooled on the second axis at the same time. Max. soldering material dimensions are 650 x 650 x 95 mm for both systems.



Loading area with a workpiece in the CondensoXP

## Automatic Inline loading/unloading



Automatic loading for the CondensoX-Line

In the CondensoX-Line, assemblies are transported using continuous workpiece carriers throughout the whole process. The workpiece carriers are automatically moved into position for loading and slide one after another onto the pre-defined locations using periphery device pushers. As soon as they are fully loaded, they are transported to the next process step. The next workpiece carrier is already being loaded so that the process chain continues to run without any interruptions. Max. soldering material dimensions are 650 x 650 x 95 mm. After the soldering process has ended with a cooling phase, the workpiece carrier is automatically unloaded using pushers. It is now passed on to return transport in its empty state, and is available for another load again.

- › **Horizontal transport** (not for the CondensoXC)
- › **PCBs are idle throughout the entire process**
- › **High-speed handling systems for high throughput**
- › **Consistently inert process atmosphere** (only with the CondensoX-Line)
- › **Modular concept, subsequent handling adaptations possible**



## Condensation soldering with or without vacuum

### Reliable and repeatable

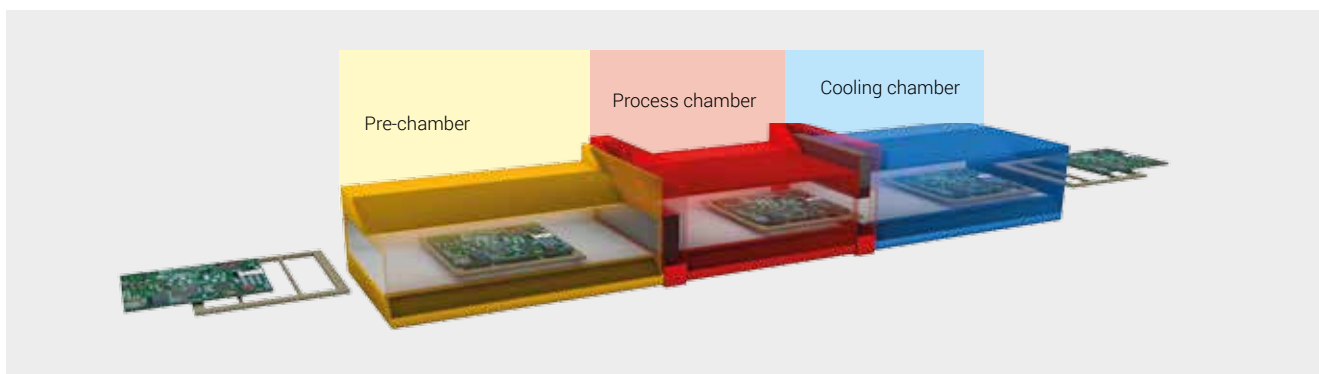
The heart of Condensox systems is the process chamber. Components are reliably soldered here, taking various parameters into account. Pressure, time or temperature can be adjusted flexibly – for top soldering results that match the requirements of your production process.

#### Pre-chamber for pre-inerting



Only the Condensox-Line also has a pre-chamber, which is hermetically sealed and can be flooded with nitrogen. This ensures an optimum, reliable atmosphere in subsequent

soldering processes. Pre-inerting improves soldered joint reliability by preventing joint parameter oxidation and minimising air pockets, even before soldering.



Construction of the 3-chamber system of the Condensox-Line

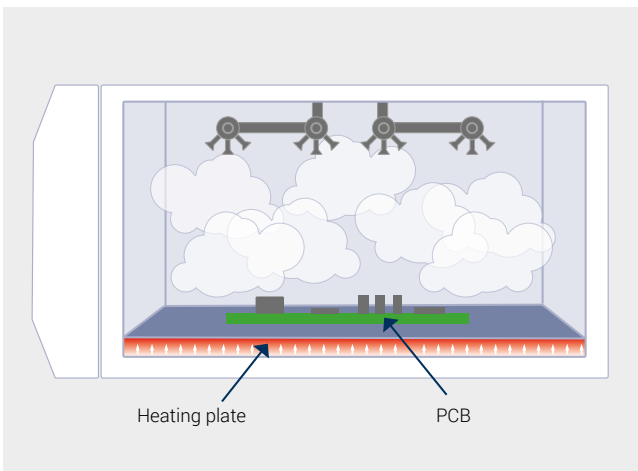


## 3-chamber system

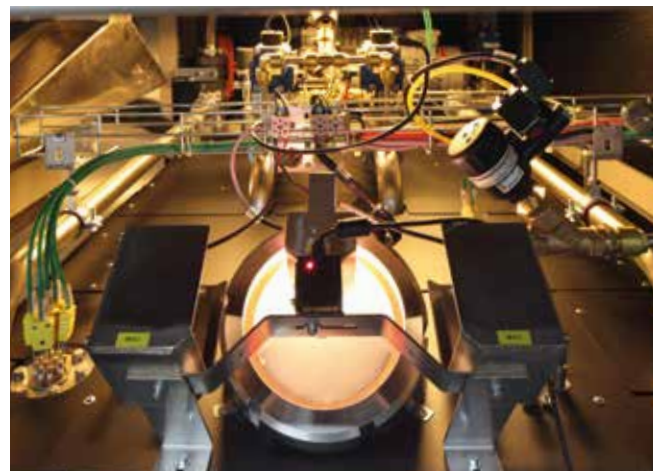
The CondensoX-Line is set up as a 3-chamber system to achieve low cycle times with inline soldering processes. The first chamber provides a protective nitrogen atmosphere for the products (pre-inerting) before it is transported to the actual soldering process. The second process chamber that is suitable for vacuum can be flooded with nitrogen or forming gases and provides an inert or activating and void-reducing process atmosphere throughout the whole soldering process. In addition, formic acid can be used as an option here

for flux-free process control – which is a first in the world of vapour phase soldering systems! Controlled, rapid assembly cooling can be achieved with less than 100 ppm residual oxygen in the atmosphere using controllable convection in the final, gas-tight cooling chamber. In this way, void-reduced soldered joints can be made in a completely inert process environment, irrespective of whether this is with standard assemblies with BGA components or a DCB substrate for power electronics.

## Process chamber



Process chamber structure for CondensoXS, XM, XP, XP HS and X-Line



Optional viewing window with camera

With all CondensoX-Series systems, the soldering process takes place in a hermetically sealed process chamber made of stainless steel or a mix of stainless steel and aluminium. The process chamber is fitted with high-quality electric panel heaters that ensure optimum process conditions. The assembly is heated up to soldering temperature by injecting and vaporising Galden®. Steam allows for optimum heat transfer to the soldering material. The heating systems' target temperature value remains constant. Therefore,

excellent, reproducible soldering results are ensured. The Galden® is fully extracted after the soldering process, and air is blown in via a nozzle system to gently bring the assemblies to lower temperatures before the actual cooling process. The systems can be optionally fitted with a viewing window or camera so that the soldering process can be observed and analysed. Soldering defects can be detected and eliminated in a timely fashion as a result.



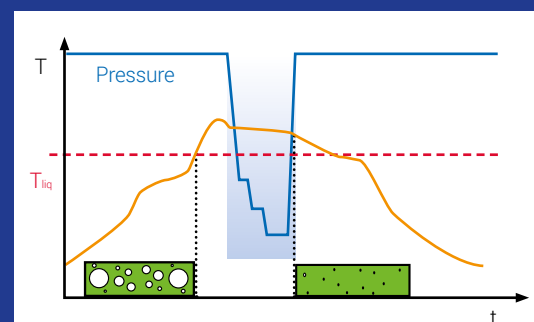
## Why vacuum?

### Reliable, reproducible soldered joints

**Void-free (cavity-free) soldering with unleaded solders is an important requirement for manufacturing power electronics. However, lower void rates can only be achieved with soldering processes where the molten solder is subjected to a vacuum.**

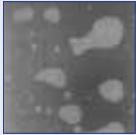

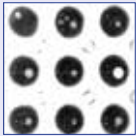
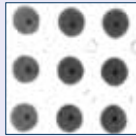




The residues that remain in the soldered joint can escape more easily due to the vacuum. The CondensoX-Series can be fitted with a vacuum pump as an option for this reason. You end up with soldered joints with a surface binding proportion of up to 99 %. Vacuum can also be drawn during the melt phase, even before the actual soldering process. This doesn't just allow the Galden® steam to be evenly distributed in the process area,

but also enables the solvent and moisture to be de-gassed from the solder paste. In addition, the atmosphere can also be varied in the process chamber throughout the whole dwell time as well the temperature.

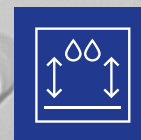


# CondensoX vacuum technology for void-free results

CondensoX vacuum technology is used in a wide range of processes. Oxidation is reduced for drying and adhesive processes, and soldered joint reliability is increased during reflow soldering by reducing voids.

Without Vacuum		With Vacuum
	Surface contacts up to 99 %	
	Improved filling of micro vias and THD-solder joints	
	Minimum of voids (particularly important on power electronics)	
	Improved wetting	

- › Pre-vacuum:
  - Prevention of oxidation, drying (solder paste, adhesives)
  - Homogeneous Galden-gas-distribution (3-dimensional soldering)
  - Micro wave plasma (pre-cleaning)
- › Vacuum during reflow soldering: Improved wetting
- › Vacuum after reflow soldering: Avoiding voids



## Void Expert – avoid a void Expert database

**Void occurrence is most certainly one of the most interesting phenomena of soft-soldering. In most soldered joints, you can usually find voids – big or small – which are formed from gas volumes caught in molten solder. These volumes are frozen when solidifying the fluid solder.**

Reliability of most soldered joints is more or less dominantly influenced by voids contained in them. As a result, a new void sensibility quality is becoming apparent in the new package trend sector such as LGA and QFN. The larger the power loss is that needs to be discharged via a soldered joint, the lower the acceptance is compared to voids. Power semiconductor soldered joints in particular should be virtually void-free.

The “Void Expert” specialist database, which has been developed in collaboration with TU Dresden, presents results that are based on AK Poren's work and on findings from previous projects, as well as international specialist literature. It should help to understand the workings of void formation and to identify essential influence quantities. Graphics and Pareto charts clearly show the parameters and interactions, and make complex links easy to understand. Conclusions can be drawn from this as to how voids can be minimised for specific cases of application. The tests carried out were evaluated with statistical methods. The discussion is attempting to clarify effects and contradictions that are particularly controversial.

# Low medium consumption

## Resource-conserving and efficient

After soldering, the assembly is passed onto the cooling process. Process gas is extracted and cleaned at the same time. Therefore, a large part of the Galden® can be reused – which is a solution that saves a great deal on materials, and is environmentally friendly! A vacuum is created during extraction which also ensures that soldering material is dried quickly.

The extracted Galden® is filtered and cleared of impurities using granules. Approx. 99.9 % of the medium can be recovered as a result. The cleaned fluid is made available in a container for other processes. "Loss of vaporisation" is low during soldering due to hermetically sealing the process chamber. As well as little need for maintenance, you benefit from low medium consumption, and save money as a result.

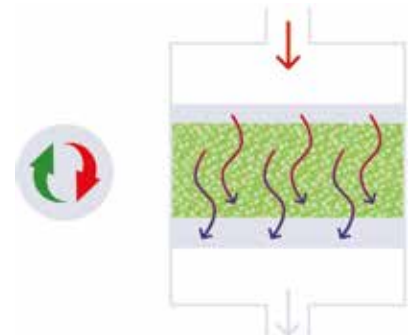
- › No loss of vaporisation in the process chamber
- › Medium filtering and re-use
- › Environmentally friendly



Galden® storage container



Filter granules

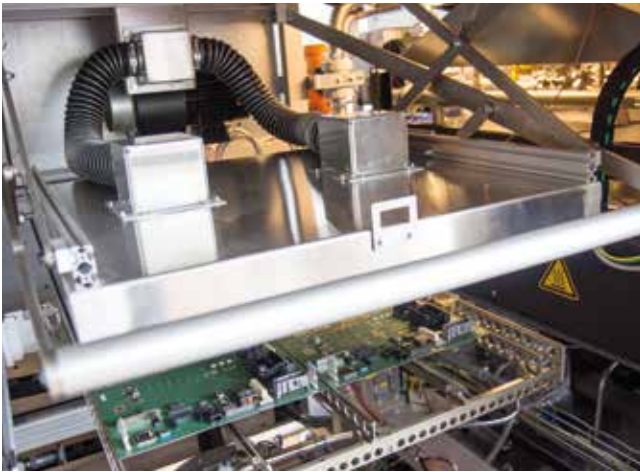


# Efficient cooling

## Hassle-free with convection and clever options

All CondensoX systems work with a cooling system as standard. The systems can also be fitted with an additional water cooling system as an option for more powerful cooling performance, or with a frequency converter for direct air flow control when cooling particularly sensitive assemblies.

### Height-adjustable cooling zone



Height-adjustable cooling unit

With CondensoXS and XM, the cooling process takes place outside the process chamber. The systems have a new, height-adjustable cooling zone with air nozzle fields. This means that the cooling process can be optimally adjusted to each assembly to bring the circuit boards to a constantly low temperature as gently as possible. The new cooling unit also ensures better air distribution during the process.

### Fixed cooling zone



The assembly is cooled in the soldering process in the CondensoXC using convection. In doing so, the assembly is blown with cold air in the process chamber by nozzle fields that have been fixed to the sides. The cooling fan speed can be individually controlled by adjusting the frequency. Then, the operator can fully pull out and remove the workpiece carrier for simple unloading. With CondensoXP and XP HS, cooling takes place outside the process chamber in a separate area. Here, cold air is blown onto the components from above from a fixed nozzle field. In doing so, the handling axle can be moved closer to the cooling area to accelerate or intensify the cooling process.



Fixed cooling zone in the CondensoXP





## Inline cooling chamber



Condensox-Line cooling chamber

With the Condensox-Line, the cooling process takes place inline in an inert atmosphere at a residual oxygen value of  $\leq 100$  ppm, and therefore protects copper for subsequent bonding processes, for example. Air or nitrogen flows onto the loaded workpiece carrier via a cooling chamber nozzle field. The process gas is cooled via water coolers before it is blown onto the assemblies once more. The workpiece carrier is automatically passed onto the unloading axis after the cooling time.

- › **Standard air cooling system for reliable cooling processes**
- › **Height-adjustable or fixed nozzle fields**
- › **Additional water cooling system available for more powerful cooling performance**
- › **Optional frequency converters for direct air flow control**



## Innovative software

### Big data and process management

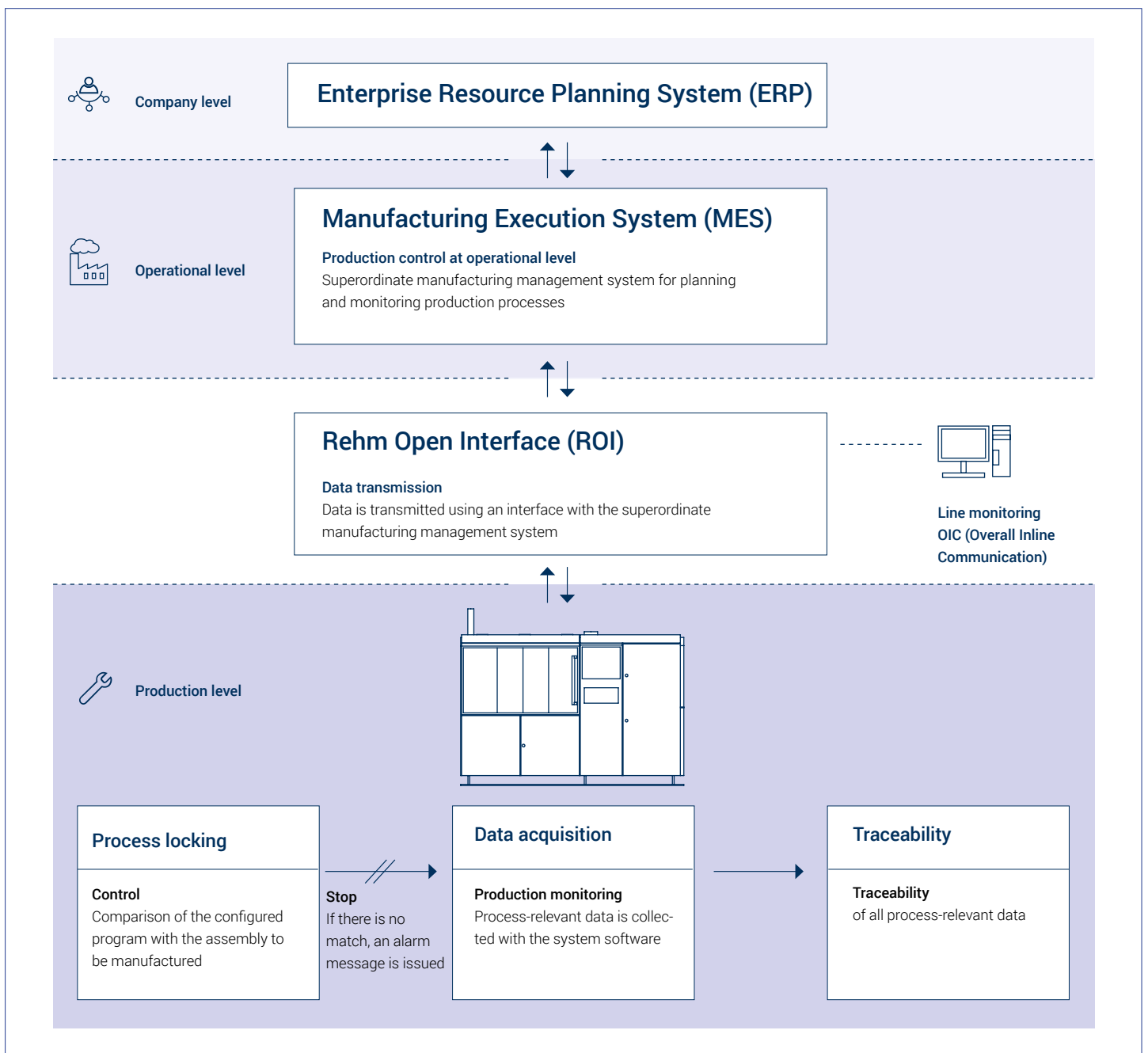
**Integrating highly specialised software in modern manufacture will become more and more common in future. Systems and processes are managed, monitored, analysed and optimised. The order, product data, efficiency and status data, specified settings, archived profiles and current values are incorporated into the machine control system product documentation and analysis.**

CondensoX-Series systems can be operated via Visu II software. This includes numerous process tools such as remote maintenance, documentation and barcode connection options to make all processes as easy as possible to follow. The intuitive user interface makes setting and operator training easy. The software also offers password-protected administration, language selection, data display and maintenance logs. The manufacturing control system can also be monitored and documented across all lines at operational level by connecting to the MES master computer.

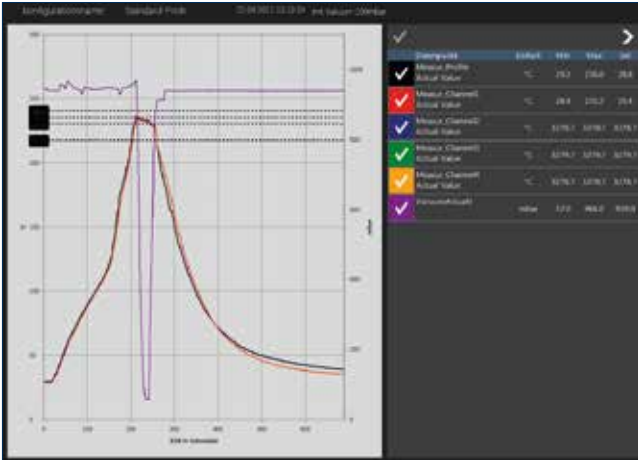
## Process documentation, traceability & co.

The variety of MES systems on the market requires individual adjustment of data transfer from the Rehm reflow soldering system to the client's superordinate manufacturing management system (MES). Superordinate to this is the ERP system, which the whole company looks at, and which allows for logistic optimisations across all sites. However, the MES system focuses on a company's individual production lines. Rehm uses an ROI interface (Rehm open interface) to transfer individual data. Machine-specific operational data that is due for the respective system is collected and passed onto the MES system as a bundle. It is possible to ensure the

seamless traceability of products, components or batches in this way. A data set is created for every assembly, which documents the relevant process parameter during the run. The assembly can be clearly identified and assigned via a barcode scan on the assembly itself, or by scanning the batch card. Process locking is also available as an option. Here, the scan is compared with the database and the assembly is only transported to the system in the event of approval. Defects can be detected and prevented in this way and therefore lead to process improvements.



## Rehm Recorder



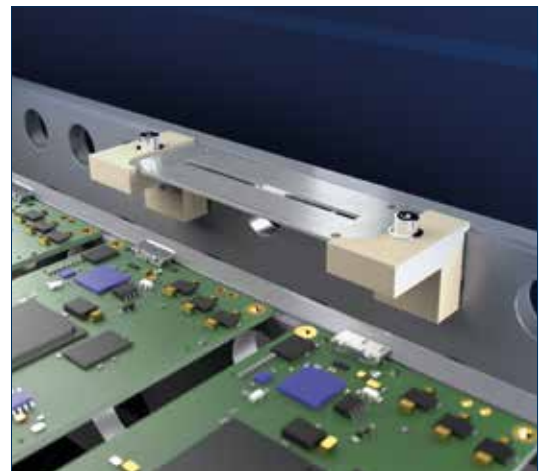
All CondensoX systems are fitted with the Rehm recorder. The documentation tool replaces external temperature recorders and records relevant process data such as temperature and pressure. Data collection and traceability are carried out at an unprecedented level – without having to interrupt production. This is how soldering profiles are accurately recorded and can be called up and reproduced every time by series production. The measured values can be shown graphically with the Rehm recorder and can therefore also be documented and compared.

## WPS 2.4 – Wireless Profiling System



The WPS 2.4 is a brand-new, wireless measuring system which is used to continuously control the temperature profile. It consists of a sensor with antennas, as well as a wireless and evaluation unit. The temperature sensor is directly attached to the workpiece carrier. It works passively and doesn't require an external energy supply. A complete soldering profile can be determined and transferred to the system software in real-time, without any annoying cables or batteries. Software-aided documentation and evaluation functions (Rehm Recorder) allows for a new, complete traceability level.

- › **100 % process monitoring**
- › **Simple, continuous proof of quality**
- › **Stable sensor function without cables or a battery**



Workpiece carrier with temperature sensor in loading position

- › **Optimal process control with the Visu II software**
- › **Traceability of all process-relevant data**
- › **Process monitoring via WPS 2.4 and a Rehm Recorder**
- › **Reliable process documentation and maintenance history**
- › **Connection to a superordinate Manufacturing Management System (MES)**

# Equipment features

## CondensoX-Series

	XC	XS	XM	XP	XP HS	X-Line
<b>VACUUM</b>						
Vacuum pump	✓	★	★	★	★	✓
Pre-vacuum	✓	✓	✓	✓	✓	✓
Intermediate vacuum	✓	✓	✓	✓	✓	✓
End vacuum	✓	✓	✓	✓	✓	✓
<b>EXHAUST PROCESS GAS</b>						
Side channel compressor	×	✓	✓	✓	✓	×
<b>GALDEN FILTERING</b>						
Filter sack with filter granules	★	★	★	★	★	★
<b>USABLE MEDIA</b>						
Galden LS215	✓	✓	✓	✓	✓	✓
Galden LS230	✓	✓	✓	✓	✓	✓
Galden HS240	✓	✓	✓	✓	✓	✓
Galden HS260	✓	✓	✓	✓	✓	✓
<b>PRODUCTION</b>						
Batch operation	✓	✓	✓	—	—	×
Inline operation	×	×	×	✓	✓	✓
<b>LOADING ASSEMBLIES ONTO THE WORKPIECE CARRIER</b>						
Manual	✓	✓	✓	—	—	×
Automatic	×	×	×	✓	✓	✓
<b>LOADING WORKPIECE CARRIER INTO PROCESS CHAMBER</b>						
Automatic	×	✓	✓	✓	✓	✓
<b>COOLING UNIT</b>						
Air cooling	✓	✓	✓	✓	✓	×
Water cooling	★	★	★	★	★	✓
Inert atmosphere can be achieved with N <sub>2</sub>	×	★	×	×	×	✓
Cooling can be controlled (frequency converter)	★	★	★	★	★	★
<b>MAINTENANCE</b>						
Maintenance management	✓	✓	✓	✓	✓	✓
<b>SOFTWARE</b>						
Production management	★	★	★	★	★	★
Process locking	×	×	×	★	★	★
Traceability	×	★	★	★	★	★
Rehm Recorder	✓	✓	✓	✓	✓	✓
Schedule (automatic programme loading)	★	★	★	★	★	★
Barcode scanner	★	★	★	★	★	★
<b>PROCESS OBSERVATION</b>						
Camera	★	★	★	★	★	★
WPS 2.4	×	★	★	★	★	×
Internal measuring channels for profiling	★	★	★	★	★	×

✓ Standard

★ Optional

— Not required

×

Not available



# Technology Center

## Experience the soldering process live.

**How is it possible to create the ideal temperature profiles?  
Or which technology is best for avoiding voids in soldered joints? Rehm can answer these questions.**

In autumn 2013, a high-tech applications and demonstration centre was opened on an area of 460 m<sup>2</sup> at the company's headquarters in Blaubeuren. Here, customers can test modules in direct application of convection, condensation and vacuum soldering processes, create individual temperature profiles and, aided by our applications specialists, define the optimal parameters for the production process.

Additionally, the Technology Center is fitted with a complete state-of-the-art SMT production line – from the paste printer through placement machines to a reflow soldering system. A complete coating line for selective conformal coating demonstrates secure protection of modules from environmental influences. At Rehm, there is also extensive equipment for module testing and for test results analysis.

You are welcome to arrange an appointment with us via [info@rehm-group.com](mailto:info@rehm-group.com) to visit the Technology Center and experience the soldering process live.



### MANUFACTURING EQUIPMENT

- › VisionXP+ / Vac, VisionXC, CondensoSXS, Protecto and RDS (Line), RDS UV
- › Templates and paste printers
- › Placement system
- › Handling system
- › Cleaning system

### TEST EQUIPMENT

- › Thermal imaging camera
- › X-ray inspection
- › BGA inspector, Fly inspector
- › Rework station

## On-site service

We are there for you worldwide.

The quality levels of our systems are of the highest order. We aim to maintain this high level in our service activities as well. From Blaubeuren via Georgia and Příbor to Szendehely or from Dongguan to Guadalajara – we are there to help for all questions related to sales and service. Anywhere in the world!

Need special advice on our systems, something fitted or a spare part? Our responsibility does not end with the sale! We remain in close contact with our clients and suppliers after they have invested in a Rehm system and make every effort to keep our response times short. We make sure we keep to delivery deadlines, installations and service inspections. And we are also available at any time for questions about applications – ensuring that your production runs smoothly.



**24 hours**  
a day available

**Service**   
from A to Z

in **24** countries  
on site 

### Your service contact person

#### Service-Center:

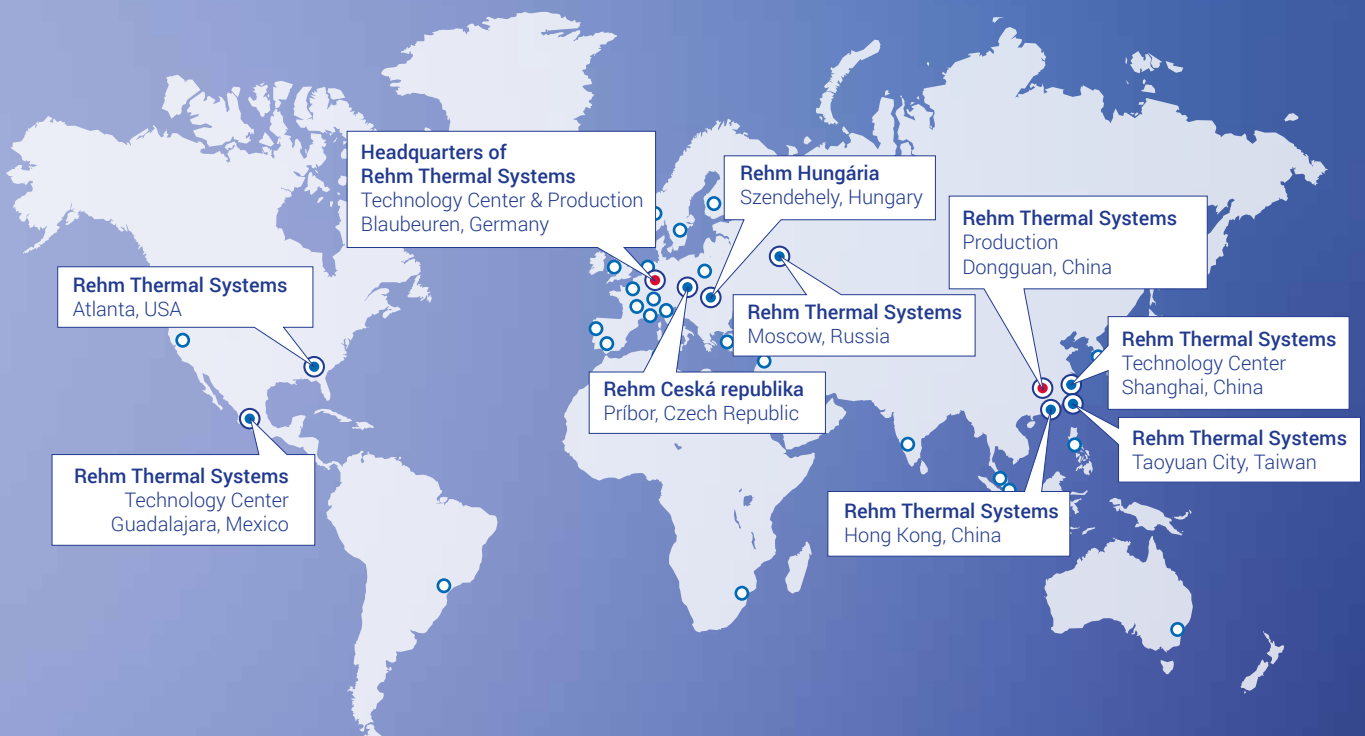
Mon - Thurs 07:00 – 16:30  
Fri 07:00 – 12:15  
[service@rehm-group.com](mailto:service@rehm-group.com)

#### 24h-Service-Hotline:

Germany: +49 (0) 7344 - 9606 511  
China: +86 769 8328 0260



**THERMAL SYSTEMS**



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## Rehm Worldwide

As a leading manufacturer of innovative thermal system solutions we have customers on every continent. With our own locations in Europe, America and Asia as well as 27 agencies in 24 countries we are able to serve the international markets quickly and to offer outstanding on-site service – worldwide and round the clock!

- Location
- Production facility
- Representation



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