TO THE GERMAN VERSION >

Copper Inductors from 3D Printing

Maximum effectiveness for every application area

- Short production times
- Economical production of individual geometries
- Precise fit and true to data

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PROTIQ
A Phoenix Contact Company

Copper as a material for industrial 3D printing

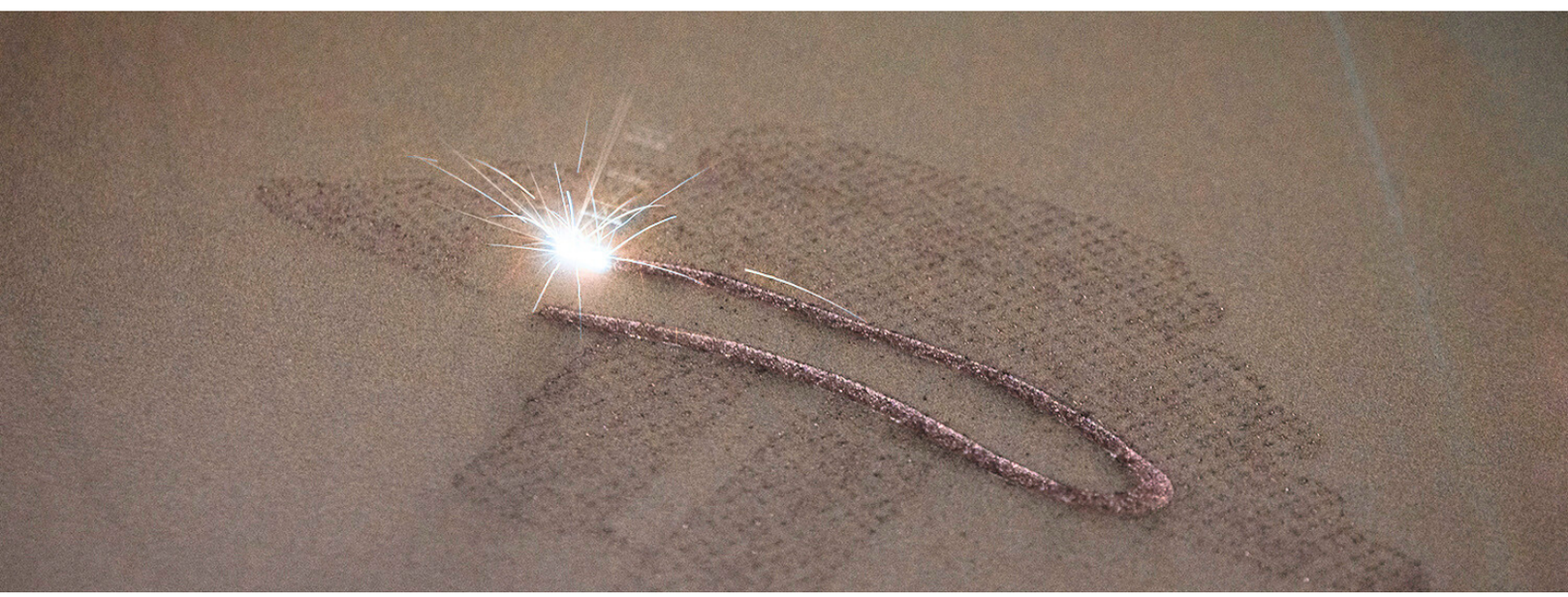
Copper was one of the first metals to be processed by man over 10,000 years ago. Today, it is a widely used metallic material in industry. Due to its excellent electrical conductivity, copper is used, among other things, to manufacture inductors for the partial hardening of components. These are traditionally shaped by hand by bending and soldering. It is important that the inductor fits the workpiece to be hardened as closely as possible.

In 3D printing, copper inductors are manufactured directly from CAD data and without the use of additional tools. Highly conductive and durable products are created that correspond exactly to the specified dimensions – a precision that is hardly achievable by conventional means. Thanks to additive manufacturing, even individual and complex geometries can be realized within a few days.

Copper, a challenge for additive manufacturing

PROTIQ manufactures inductors additively by selective laser melting. Since copper reflects the radiation of conventional laser melting systems to a large extent, alloys with a comparatively low copper content are often used. However, the conductivity of these mixtures is significantly reduced.

Back in 2011, PROTIQ succeeded in developing a unique process with which highly conductive copper can be additively processed. This made us one of the first 3D printing providers able to produce copper inductors of the highest industrial quality.



Advantages of additively manufactured copper inductors

Induction hardening requires precisely fitting inductors for hardening different component shapes. Until now, these have mostly been produced by hand in complex processes. PROTIQ produces your individual inductors quickly and cost-effectively using 3D printing.

Economic production
With our online configurator, you only need a few clicks to design inductors according to specific specifications. The configuration is based on the modular principle and takes into account the special requirements of industrial customers. Of course, you also have the option of using your own 3D files.

Longer service life
Due to the more uniform load during heating, additively manufactured inductors have a longer service life. This allows you to noticeably reduce the ongoing costs for new purchases.

Better control of the induction process
Due to the optimal and uniform adaptation of the inductor to the workpiece to be hardened, the heat reaches the material more evenly with less energy input. The hardened components are therefore more resilient and durable.

No solder joints
Copper inductors from 3D printing are manufactured "from one cast" and have a very uniform surface. Therefore, they require significantly less energy for a comparable performance than conventionally manufactured inductors.

Precisely fitting and true-to-data implementation
Thanks to the fully digital business processes on the PROTIQ Marketplace, you benefit from 100% data consistency as well as maximum precision and reliability in production.

Short delivery times even for complex shapes
For the realisation of demanding geometries, 3D printing does not require any special tools that would have to be purchased or even manufactured in advance. Therefore, production can start immediately after receipt of the order. You will receive your ready-to-use inductor within a few working days.

Reproducible quality
Our quality management system is audited and certified according to ISO 9001. Standardised processes guarantee a consistently high quality of your copper inductors.

Shorter cycle times
Thanks to the optimised mould design, thermal performance improves, effectively reducing cycle times in mould production.

Highly conductive copper for 3D printing

	Copper content	Density	Elongation at break	Tensile strength	Electrical conductivity
RS-CU	99%	8,8 g/cm³	20 ± 5 %	220 ± 30 MPa	up to 50 MS/m
CU	100%	8,9 g/cm³	50 ± 10 %	220 ± 10 MPa	up to 57 MS/m

Disadvantages of conventionally manufactured inductors

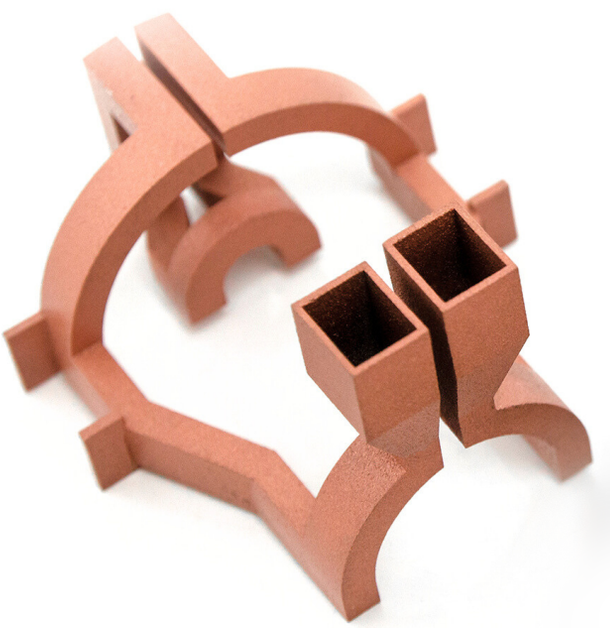
1. Solder joints cause disturbances in the current flow and cause high energy loss. The more complex the inductor shape, the more solder joints are needed.

2. The quality cannot be reproduced one-to-one by hand. The service life of two inductors with an identical shape can therefore vary greatly.

3. Manual production restricts the shaping. Complex geometries cannot be realised by manual bending and soldering.

4. The manual production of inductors is very demanding and therefore time-consuming and cost-intensive.

5. The smallest shape deviations result in high setup times for the user. Setting up a new inductor can take several weeks.



How 3D printing works on PROTIQ Marketplace

Creation of your 3D file

Create your individual 3D object yourself, use our engineering service or one of our free 3D configurators.

Configuring your 3D object

Upload your own CAD files and design your 3D model according to your requirements. The costs are displayed directly online.

We print your 3D model

Immediately after receiving your order, the order is fully automatically entered into the system of one of our over 40 merchants.

You receive your product

Manufacturing of your 3D object can begin as soon as we receive your order, so your product is ready for delivery as quickly as possible.

Induction hardening in industry

Induction hardening has established itself as an indispensable process in the metalworking industry. Thanks to its precision and speed, it is the method of choice for hardening components subjected to extremely high loads. This technology is widely used in various fields, including toolmaking, manufacturing of gearboxes, camshafts and gears.

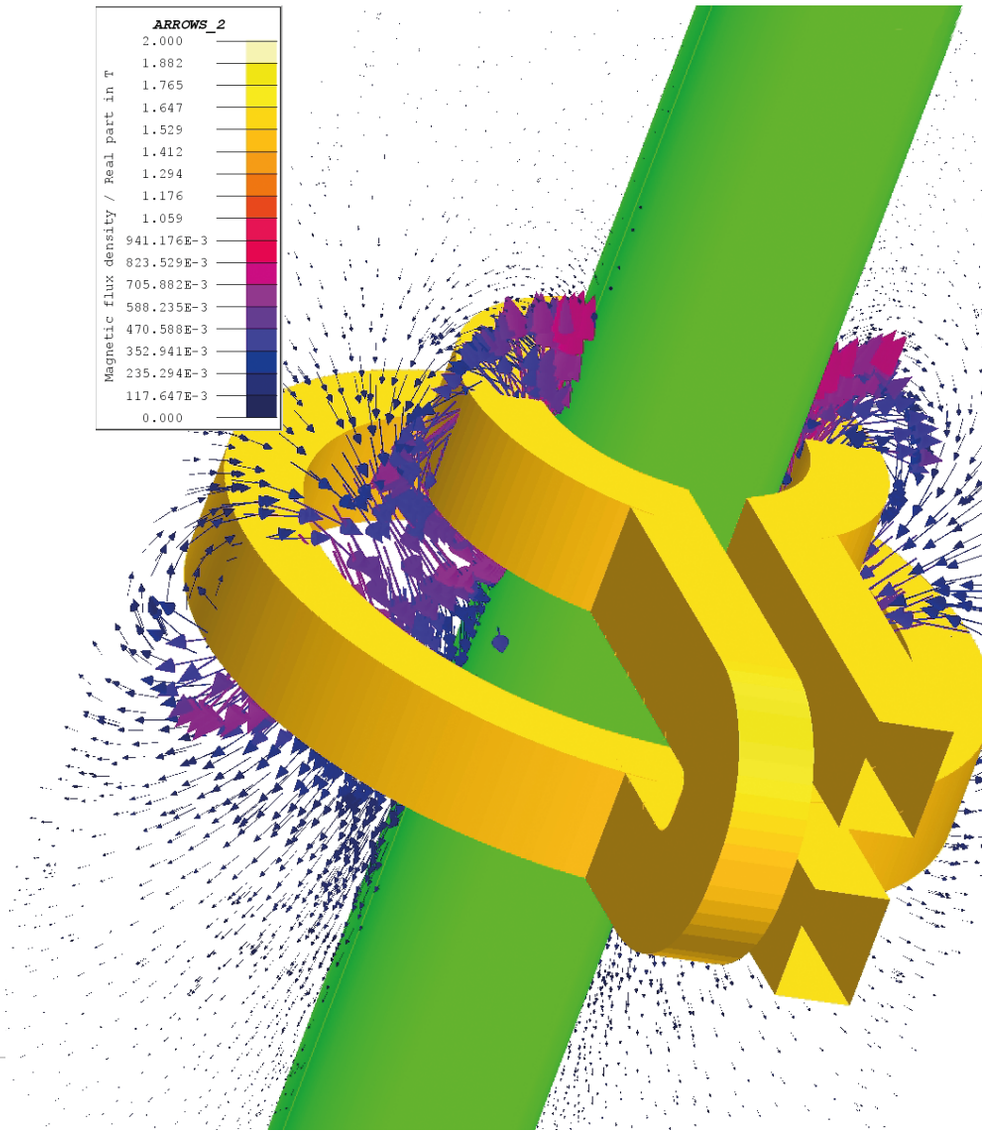
In addition, induction hardening offers a number of advantages over conventional hardening processes. It enables pinpoint heat treatment and thus minimizes the risk of deformation and cracks in the material. This results in an increased service life of the treated components, leading to improved cost efficiency. Short cycle times and the possibility of integration into automated manufacturing processes make it a particularly economical option for modern production facilities.

Induction heating creates an extraordinary surface hardness with a high case hardness depth (CHD) in the component, making the workpiece particularly resistant.

In induction hardening, only certain areas of a component are hardened. This is why the term partial hardening is used in this context. Since heat is generated only at the points where electromagnetic eddy currents are induced in the workpiece, the precisely fitting shape of the inductor is an important quality factor.

On the PROTIQ Marketplace you have the possibility to have copper inductors manufactured in special shapes for extraordinary applications.

Thanks to its great expertise in simulation-based magnetic field design, the PROTIQ team is also your contact for optimizing your established induction processes. We can for example use magnetic field simulation to determine the ideal basic shape for your inductors. This way, the efficiency of inductive heat generation can be significantly improved.



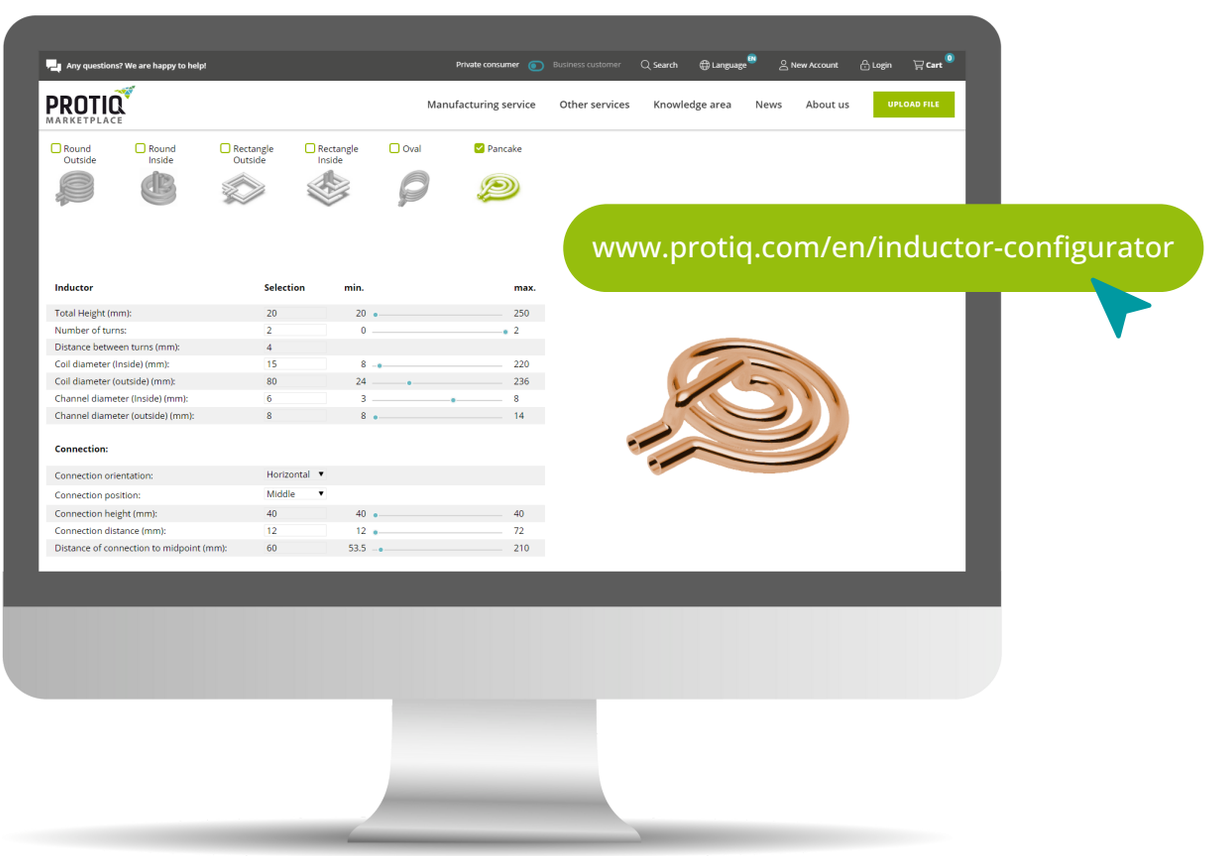
The simulation of the magnetic field shows at which points the electromagnetic effect penetrates the component.

The inductor configurator by PROTIQ

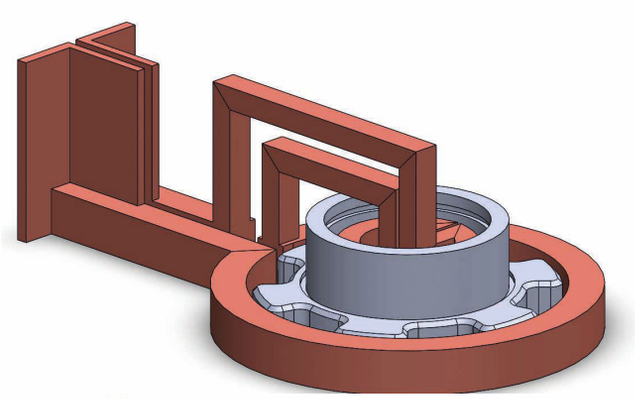
Our inductor configurator, in combination with tool-free manufacturing in 3D printing, significantly shortens the lengthy manufacturing process for inductors. Choose your optimal basic geometry from six different basic shapes, which you can adapt with just a few clicks according to the modular principle. You will receive your ready-to-use inductor just a few days after receiving your order, because industrial 3D printing production can start immediately. This immediate availability not only accelerates your time-to-market, but also enables greater flexibility in product development. In addition, we rely on the highest quality standards to ensure that your inductor meets the specific requirements of your applications.

Advantages of the inductor configurator

- Intuitive handling
- Individual design options
- Real time price calculation
- Guaranteed printability of the 3D models
- Economical thanks to modular design and tool-free production
- Compliance with all EU data protection laws

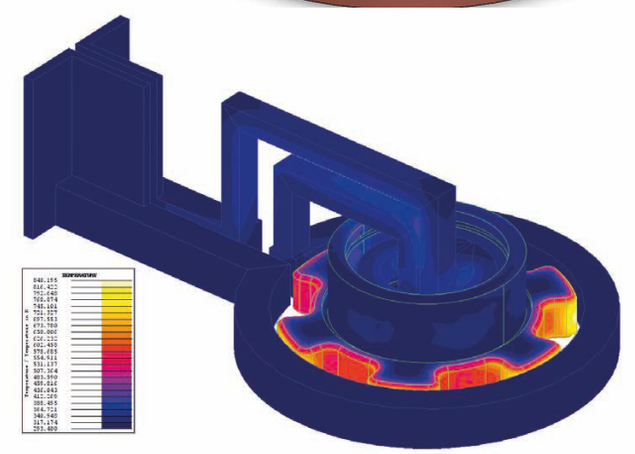


Optimisation of inductors



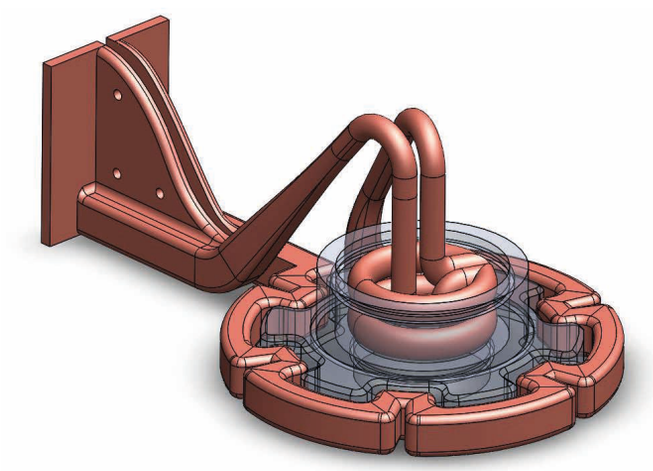
Step 1

Analysis of the conventional inductor geometry. The shape of the copper tubes is based on the maximum diameter of the workpiece to be hardened. The circular shape of the inductor cannot reach the recesses in the component.



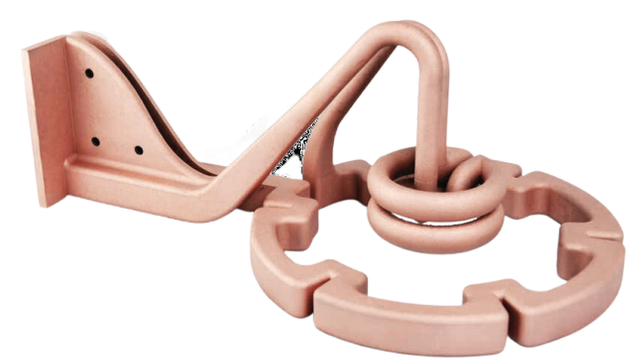
Step 2

Simulation of the heat distribution during the induction process. The variable air gap between the component and the inductor results in differences in the heating pattern, which can negatively influence the hardening process.



Step 3

Construction of the optimized geometry. The shape of the copper tube is adapted to the contour of the component to be cured. In this way, uniform temperature conditions are generated in all areas of the component surface.



Step 4

The final inductor is manufactured in 3D printing by selective laser melting from highly electrically conductive copper. Thanks to the optimized geometry, the induction process can now be carried out even more precisely. The result: higher and more consistent component quality with simultaneously reduced scrap rates and reduced cycle time.

PDF brochure

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