

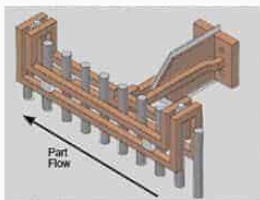
Custom Induction Heating Coils

Design and manufacturing of induction coils for brazing, hardening, forging, shrink fitting, pipe heating and melting, matched to your parts and your power supply.

Types of Coils



Oval Helical Coil



Channel Coil



Helical Coil (encircling)



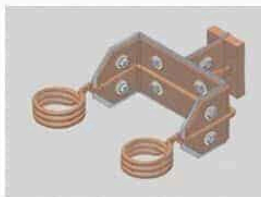
Open Ended Coil



Inside (ID) Coil



ID / OD Coil Assembly



Multi-Position Brazing Coil



Quick Disconnect Assembly



Pancake Coil

0.5–500 kHz

frequency range
covered

3–1,500 kW

power supplies
matched

**11+ coil
types**

helical to flexible cable

Free

sample part evaluation

Why the coil decides your heating result

The induction coil (inductor) carries current from the power supply and creates the magnetic field that heats the part. It decides where the heat goes, how fast it builds up and how much of the generator's power reaches the workpiece. HLQ designs every coil for a specific part and process and matches it to the power supply, so you get the right heating pattern at full rated power.



Custom coils for brazing, hardening, annealing and heating



Coils with flux concentrators and terminal plates

What we design

- Coils for new HLQ induction systems
- Replacement and improved coils for existing lines
- Coils for other brands of power supply (with interface data)
- Spare coils and concentrators for production

What you gain

- Heat exactly where it is needed
- Shorter cycle times at the same power
- Repeatable quality and longer coil life



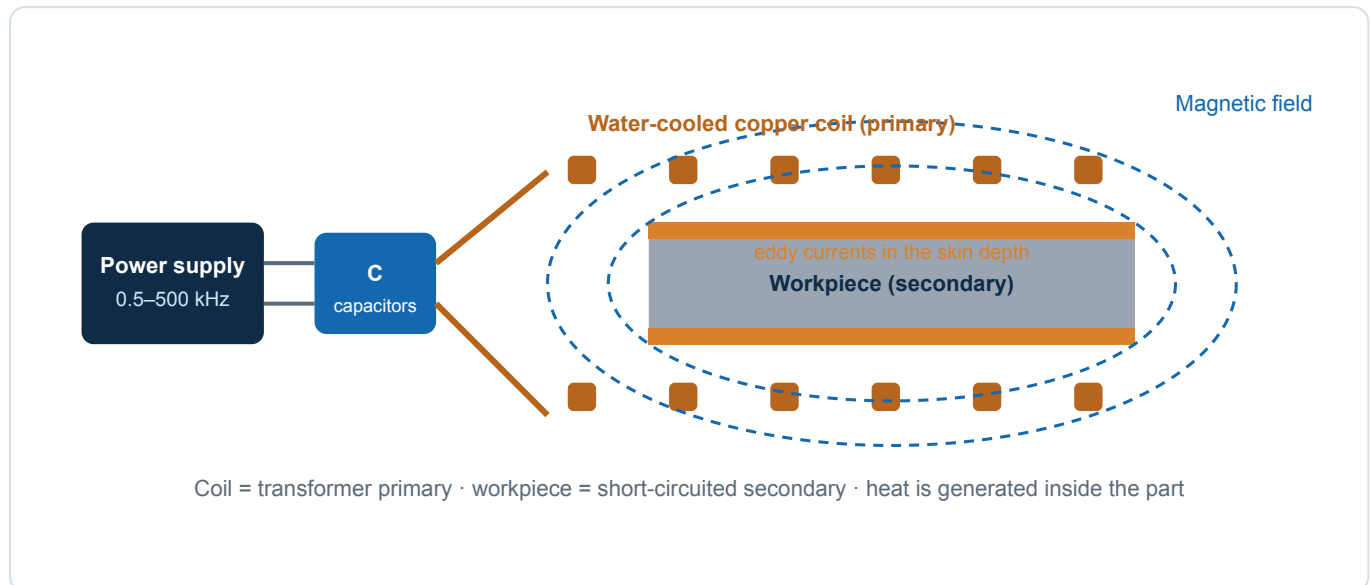
Channel coil with concentrator

Induction coil types

Coil type	Shape	Best for	Design note
Helical (encircling) coil	Round or oval multi-turn solenoid around the part	Shafts, tubes, bars, through-heating, shrink fitting	Most efficient general-purpose shape; strongest field inside the turns
Oval or rectangular helical coil	Turns shaped to the part profile	Flat bars, strip, non-round parts	Keeps a uniform gap around non-round sections
Pancake (spiral) coil	Flat spiral on one side of the part	Flat surfaces, sealing, one-sided heating	Heating concentrates under the turns; the centre is weaker
Channel (hairpin) coil	Long open channel the parts pass through	Conveyor brazing, annealing many parts in line	Parts move continuously; good for automation
Inside (ID) coil	Coil inserted into a bore	Bore hardening, internal brazing	Needs flux concentrators; efficiency is lower than encircling coils
ID / OD coil assembly	Coils inside and outside the part	Tube-to-fitting joints, thick sections	Heats from both sides for even temperature
Open-ended or split coil	C-shape or hinged coil	Parts that cannot pass through a closed coil	Allows loading from the side
Multi-position brazing coil	Several heating zones in one coil	Brazing several joints at once	Balances heat between joints of different size
Single-turn and scanning inductors	One turn, often with an integral quench spray	Surface hardening of shafts and gears	Narrow heating band moved along the part
Quick-disconnect coil	Coil on a quick-change connector block	Frequent coil changes in production	Short change-over, repeatable positioning
Flexible cable coil	Water- or air-cooled cable wrapped on site	Pipe preheating and post-weld heat treatment	Adapts to any pipe size in the field

Coil drawings and images: HLQ coil design library.

How induction coil design works



The coil behaves like the primary winding of a transformer and the workpiece like a short-circuited secondary. Alternating current in the coil creates a magnetic field that induces eddy currents in the part, and the part's own resistance turns them into heat.

Four design rules

- 1 **Couple closely.** Efficiency falls quickly as the gap grows.
- 2 **Heat where the turns are.** The field is strongest next to the copper; an off-centre part heats unevenly.
- 3 **Shape the field.** Turn spacing, turn count and flux concentrators place the heat.
- 4 **Match the generator.** Inductance and turns are chosen so the power supply delivers its rated power.

Design variable	Effect on heating	Typical choice
Coupling gap	Smaller gap means higher efficiency and faster heating	As small as loading, tolerances and insulation allow
Number of turns	Affects coil impedance, heated length and uniformity	Chosen to match the power supply and heated length
Turn spacing	Close spacing gives intense heat; wider spacing evens it out	Varied along the coil to balance the heat pattern
Coil length vs heated zone	Ends of a helical coil heat less than the middle	Coil slightly longer than the zone, or extra turns at the ends
Flux concentrator	Concentrates the field and raises efficiency	Essential for ID coils, single-turn and pancake coils
Frequency	Sets the depth of the induced current	Higher for thin cases and small parts; lower for through-heating

Design capabilities and parameters

Parameter	Specification	Notes
Product	Custom induction heating coils (inductors)	Designed for each part and process
Coil types	Helical, oval, pancake, channel, ID, ID/OD, open-ended, split, multi-position, single-turn, scanning, flexible cable	See the coil types table
Frequency range	About 0.5 kHz to 500 kHz	Matched to HLQ KGPS, medium-frequency, high-frequency and ultra-high-frequency power supplies
Power range	About 3 kW to 1,500 kW	From desktop units to KGPS systems
Conductor	Round, square or rectangular copper tubing, typically high-conductivity copper	Size chosen for current and cooling flow
Joints	Silver-brazed copper joints	Leak-tested before delivery
Cooling	Internal water cooling; air-cooled or water-cooled flexible cables for PWHT	Flow designed for the coil's heat load
Flux concentrators	Soft-magnetic composite, ferrite or laminated silicon steel	Selected by frequency and power density
Insulation	Coil coating, fiberglass sleeving, castable refractory or liners	Depends on temperature and wear
Connection	Bolted terminal plates or quick-disconnect blocks	Matched to the heating station
Quench (hardening coils)	Integral spray holes or separate spray ring	Hole pattern designed for even cooling
Input from customer	Drawing or sample part, material, target temperature and pattern, cycle time	Free evaluation of sample parts

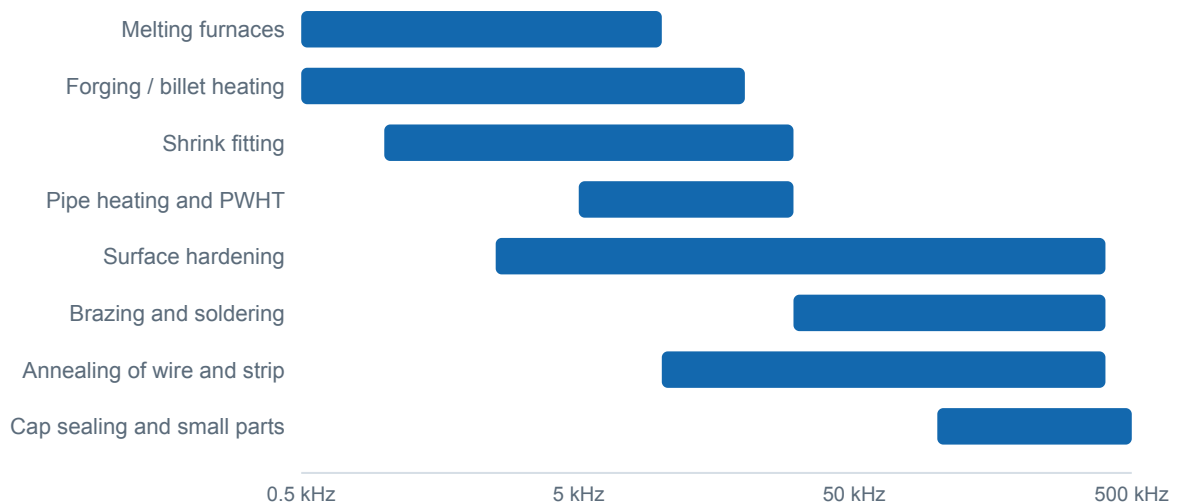
Materials, cooling and construction

Item	Options	Selection guideline
Copper tube profile	Round, square, rectangular	Square and rectangular tubes give a flat face to the part and higher current capacity
Wall thickness	Thin to heavy-wall	About twice the penetration depth in copper at the working frequency is usually sufficient
Flux concentrator	Soft-magnetic composite, ferrite, silicon-steel laminations	Composites for complex shapes; ferrite for very high frequency; laminations for low frequency and high power
Insulation and protection	Coil coating, sleeving, castable refractory, wear liners	Protects against arcing, scale and mechanical wear
Quench system	Integral spray holes or separate spray ring	Integral quench for scanning; separate ring for easier maintenance
Water	Deionized or softened, closed loop	Prevents scale inside thin coil tubes
Mounting	Terminal plates, quick-disconnect blocks, support brackets	Rigid support keeps the gap constant and prevents fatigue cracks

Coil selection by application

Application	Material	Recommended power	Frequency	Recommended coil
Brazing copper tube joints, Ø6–22 mm	Copper, brass	About 6–25 kW	About 30–100 kHz	2–4 turn helical or open-ended coil
Brazing carbide tips to saw blades and tools	Tool steel and carbide	About 6–15 kW	About 100–300 kHz	Small helical or hairpin coil
Hardening small pins and shafts, Ø10–30 mm	Medium-carbon and alloy steel	About 15–60 kW	About 30–200 kHz	Single-turn scanning coil with quench
Hardening large shafts and gears, depth 3–5 mm	Alloy steel	About 100–300 kW	About 2.5–10 kHz	Single-turn or profile coil with concentrator
Shrink fitting bearings and couplings	Steel	About 10–100 kW	About 1–30 kHz	Helical, ID or flexible coil
Bar-end forging, Ø20–60 mm	Carbon steel	About 35–160 kW	About 3–20 kHz	Multi-turn channel or tunnel coil
Billet through-heating, Ø60–150 mm	Steel, copper, aluminum	About 160–1,000 kW	About 0.5–3 kHz	Multi-section tunnel coil line
Pipe preheating and PWHT	Carbon and alloy steel pipe	About 20–120 kW	About 5–30 kHz	Flexible cable coil
Melting 5–250 kg	Gold, copper, aluminum, steel	About 15–160 kW	About 1–20 kHz	Multi-turn crucible coil

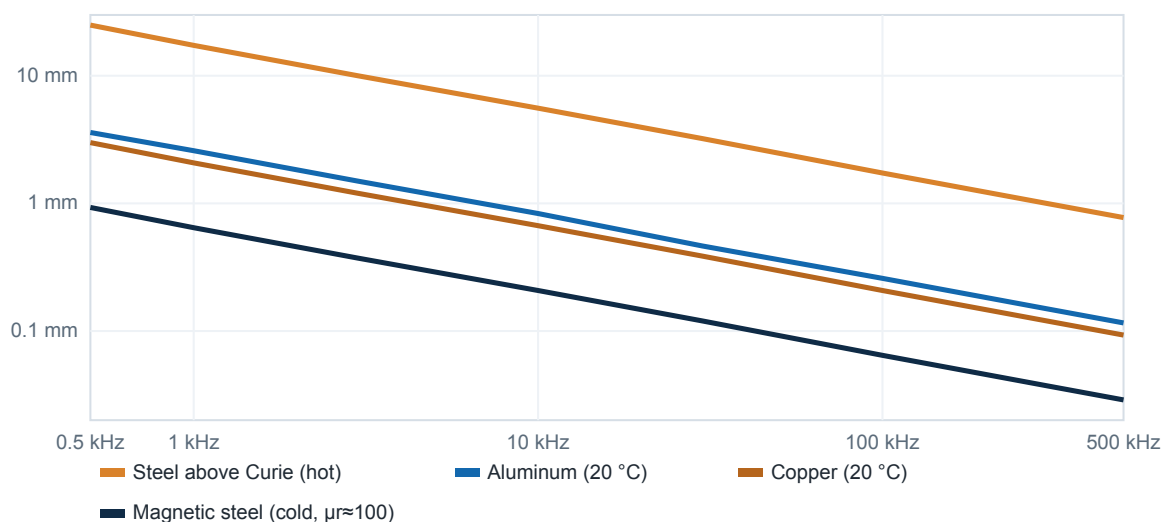
Typical operating frequency by application



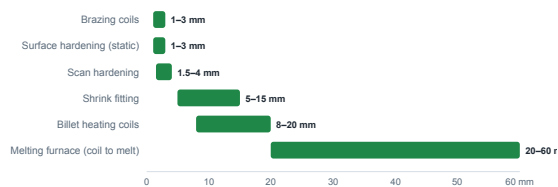
Engineering calculations

Penetration depth: δ (mm) $\approx 503 \times \sqrt{(\rho \div (\mu r \times f)) \times 1,000}$. For through-heating, keep the part diameter at least 3–4 $\times \delta$; for hardening, choose a frequency whose hot δ is close to the case depth.

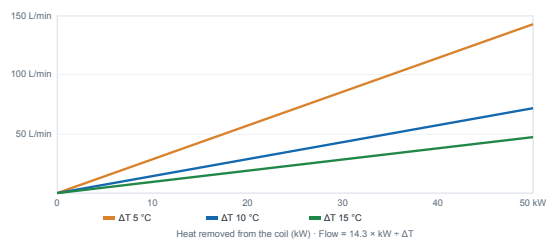
Calculated penetration depth vs frequency



Typical coupling gap



Cooling water: flow = $14.3 \times \text{kW} \div \Delta T$



Typical application set-ups

The examples below show typical coil and power combinations for common jobs. Exact parameters are confirmed by calculation and heating trials on your parts.

HVAC copper tube brazing

Workpiece	Ø12.7 mm copper tube to brass fitting
Coil	2-turn open-ended coil
Power / freq.	About 15 kW, 30–100 kHz
Result	About 8–15 s per joint

Carbide tip brazing

Workpiece	Carbide tips on steel saw body
Coil	Small hairpin coil
Power / freq.	About 6–10 kW, 100–300 kHz
Result	A few seconds per tooth

Shaft scan hardening

Workpiece	Ø40 mm alloy steel, 15 mm heated band
Coil	Single-turn coil with integral quench
Power / freq.	About 28 kW ($\approx 1.5 \text{ kW/cm}^2$), 30–50 kHz
Result	Scanning speed sets case depth

Bar-end forging

Workpiece	Ø30 mm carbon steel, 80 mm heated length
Coil	Multi-turn channel coil
Power / freq.	About 35–50 kW, 8–15 kHz
Result	Continuous feed to the press

Bearing shrink fitting

Workpiece	Bearing inner race to about 120 °C
Coil	Helical or inside coil
Power / freq.	About 10–20 kW, 10–20 kHz
Result	Uniform, controlled heating

Pipe preheating / PWHT

Workpiece	Ø219 mm steel pipe weld zone
Coil	Flexible cable coil
Power / freq.	About 40 kW, 10–25 kHz
Result	Up to about 600–720 °C hold

Power density guide

Process	Typical surface power density	Why
Through-heating (forging, shrink fitting)	About 0.05–0.3 kW/cm ²	Slow enough for heat to soak to the core
Brazing	About 0.3–1 kW/cm ²	Fast, but the joint must heat evenly so the filler flows
Surface hardening	About 0.8–2 kW/cm ²	Heats the surface before the core warms up

Required power $\approx$ heated surface area (cm²) $\times$ power density (kW/cm²).

Our coil design process

Step	What happens	What you receive
1. Requirements	You send drawings or sample parts, material, heated zone, target temperature and cycle time	Confirmation of the heating task
2. Feasibility	We select frequency, power and coil type, and check coupling and power density	Recommended power supply and coil concept
3. Coil design	Turns, spacing, profile, concentrators, cooling circuits and mounting are designed	Coil drawing for approval
4. Prototype and test	The coil is built and tested on sample parts where possible	Heating pattern, time and temperature results
5. Refinement	Spacing, gap or concentrators are adjusted to correct the pattern	Final coil design
6. Production and inspection	Brazing, pressure and flow testing, dimensional check	Production coil, ready to connect
7. Spares	Duplicate coils or spare concentrators on request	Less downtime in production

Common coil problems and solutions

Problem	Likely cause	Solution
Uneven heating around the part	Part off-centre, uneven gap	Improve fixturing; use a locating nest or guides
Ends of the part stay cool	Weaker field at the coil ends	Lengthen the coil or tighten the end turns
Generator cannot reach rated power	Coil impedance not matched, gap too large	Change turn count, reduce the gap, retune the capacitors
Hot spots at sharp edges or holes	Current concentrates at edges	Increase local gap, adjust turn spacing, lower frequency
Coil overheats or cracks	Low water flow, scale, mechanical vibration	Increase flow, use soft water, add rigid supports
Arcing between turns or to the part	Damaged insulation, scale or spatter	Re-insulate the coil, clean regularly, add a liner
Concentrator burns or crumbles	Power density too high for the material, poor cooling	Choose a higher-rated concentrator and cool it properly

Frequently asked questions

1. What information do you need to design an induction coil?

A drawing or sample of the part, the material, the zone to be heated, the target temperature or hardness pattern, the cycle time and the power supply you use or plan to buy.

2. How close should the coil be to the part?

As close as the process allows. Typical gaps are about 1–3 mm for brazing and hardening, 5–15 mm for shrink fitting and 8–20 mm for billet heating coils with liners.

3. How do I choose the frequency?

Use the penetration depth: higher frequency for small parts and thin hardened cases, lower frequency for large parts and through-heating. For through-heating, the diameter should be at least three to four times the penetration depth.

4. Why does my part heat more on one side?

The part is probably off-centre. The field is strongest next to the copper turns, so the side closer to the coil heats faster. Better fixturing or a locating nest solves this.

5. What is a flux concentrator and do I need one?

It is a magnetic material placed around part of the coil to concentrate the field where heat is needed. It is essential for inside (ID), single-turn and pancake coils, and often raises efficiency considerably.

6. How much cooling water does a coil need?

$\text{Flow (L/min)} = 14.3 \times \text{coil heat (kW)} \div \text{temperature rise (}^{\circ}\text{C)}$. For example, 15 kW of coil heat with a 10 °C rise needs about 21 L/min of clean, soft water.

7. Can you make a coil for another brand of induction heater?

Often yes, if you provide the power supply's frequency range, output voltage and connection details so that the coil can be matched to it.

8. How long does an induction coil last?

It depends on the process. Brazing and heating coils can last for years with good cooling and support, while hardening and forging coils wear faster and are best kept as spares.

Request a coil design

Send us the information below and our engineers will reply with a coil concept, power and frequency recommendation, and a quotation.

Please include

- Drawing or photos of the part, with the zone to be heated marked
- Material grade and any coating
- Target temperature, hardness pattern or joint requirement
- Required cycle time or parts per hour
- Your power supply (brand, model, frequency, output voltage) or the one you plan to buy
- Cooling water available and any space limits at the heating station
- Sample parts for a free heating evaluation, if possible

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Coils, induction power supplies and complete heating systems from one supplier.

Frequency and power ranges refer to HLQ induction power supplies. Penetration depths are calculated values; gaps, power densities and application parameters are typical engineering values and are confirmed for each project. Edition October 2026.