

## Recommendations for using cartridge heaters

### installation, operation and maintenance

Technical recommendation by Elektron-ETTO s.r.o.

The service life and reliability of cartridge heaters depend on mutually interacting factors: the working temperature, the watt density of the surface ( $W/cm^2$ ), the type of heated metal and the maximum actual gap between the cartridge heater and the bore. This document summarises recommendations for the correct installation, electrical connection and maintenance of cartridge heaters; following them significantly extends their service life and ensures stable operation.

#### 1. Installing the cartridge heater into the heated part

- The **ideal method** of installing cartridge heaters is **fitting them into a split sleeve**, which ensures uniform thermal contact around the entire circumference of the cartridge heater.
- At a watt density of the cartridge heater **up to  $20 W/cm^2$** , a **cylindrical bore with H7 tolerance** and a surface roughness of **Ra max.  $0.8 \mu m$**  may be used. The bore should **preferably be a through hole** to make later replacement of the cartridge heaters easier.
- A bore with H7 tolerance is produced with a **reamer**. The diameter of the drilled bore prior to reaming should be within the tolerance of  **$-0.2 mm / -0.3 mm$**  for steel parts and  **$-0.3 mm / -0.4 mm$**  for parts made of brass, bronze or aluminium.

#### 2. Arrangement of multiple cartridge heaters in the heated part

When several cartridge heaters are arranged in a row, the ideal distance between them – with regard to the **service life of the cartridge heaters** and **uniform temperature distribution** – should be **equal to the diameter of the cartridge heaters**. Too small a pitch causes mutual thermal interaction and the formation of hot spots.

#### 3. Watt density and working temperature

The decisive and mutually interacting factors of contact heating of metal parts with cartridge heaters are:

Factor	Description
<b>Working temperature</b>	With the other parameters suitably selected, the working temperature can be <b>up to <math>750 ^\circ C</math></b> . A higher temperature significantly shortens the service life of the cartridge heater.
<b>Watt density of the surface</b>	Expressed in $W/cm^2$ . For a cylindrical H7 bore, the recommended limit is <b><math>20 W/cm^2</math></b> ; for higher loads, a split sleeve or an offset pressed joint must be used.
<b>Type of heated metal</b>	The thermal conductivity and the coefficient of thermal expansion of the metal (steel, brass, bronze, aluminium) influence the size of the actual gap at operating temperature and the heat distribution.
<b>Actual gap</b> <i>between the cartridge heater and the bore</i>	A key parameter for heat transfer. A larger clearance leads to a sudden increase in the sheath temperature of the cartridge heater – the recommended bore tolerances must therefore be observed.

#### 4. Electrical leads and their entry point into the cartridge heater

The electrical leads and their entry point into the cartridge heater must **not be exposed to:**

- **vibrations**, movement and mechanical stress,
- **contamination by liquids** of any kind, by grease and by non-inert gases.

If these influences cannot be avoided, an appropriate type of cartridge heater termination must be selected (see "Standard methods of electrical connection of cartridge heaters").

The leads and termination of the cartridge heaters must not be recessed into the heated plate. If the service life of the cartridge heaters is a problem in the area of the leads, the influences that may be the cause (vibrations, chemicals, movement, temperature) must be checked and a suitable method of electrical connection chosen.

### 5. Insulation resistance and drying of the cartridge heater

If the termination of the cartridge heater is **not watertight** (which can only be achieved at lower working temperatures – see “Standard electrical termination of cartridge heaters”), or if the cartridge heater is **not located in an environment with a maximum air humidity of up to 70 %**, the insulation resistance must be measured upon **first use and after every longer shutdown**.

If the value of the insulation resistance in the cold state at **500 V DC** is lower than **200 MΩ** (see EN 60335-1), the cartridge heater must be dried at a temperature of **105 °C – 200 °C** (depending on the type of cartridge heater leads) for **2–3 hours**. Drying can be carried out **in an oven**, or by **operating the cartridge heater at 1/3 of its rated power**.

### 6. Grounding

If the cartridge heaters are not equipped with a **grounding conductor**, the **heated metal part must be grounded**. This ensures protection against dangerous contact voltage in the event of an insulation fault.

#### Summary of key parameters

Parameter	Recommendation
Bore for the cartridge heater	cylindrical H7, roughness Ra max. 0.8 μm, ideally a through hole
Watt density (cylindrical H7)	up to 20 W/cm <sup>2</sup> ; for higher loads a split sleeve
Distance of cartridge heaters in a row	= cartridge heater diameter (ideal uniform temperature distribution)
Working temperature	up to 750 °C with suitably selected parameters
Insulation resistance	min. 200 MΩ at 500 V DC in the cold state (EN 60335-1)
Drying of the cartridge heater	105 – 200 °C for 2–3 hours, or operation at 1/3 of the rated power
Grounding	grounding conductor of the cartridge heater, otherwise <b>ground the heated metal part</b>

*For more information, assistance with specific heating situations, or any new, untested application of cartridge heaters, please do not hesitate to contact us at [info@etto.cz](mailto:info@etto.cz) or +420 581 626 366.*