Kanthal® Super
Electric heating elements

Products and accessories
Kanthal® Super Electric heating elements

Kanthal is a world-renowned brand within the field of electric heating technology. The Kanthal products offer possibilities for increased and quality improved production for furnaces while its long life cycle provides cost cutting due to less maintenance and service.

This handbook is an aid when installing and operating our Kanthal Super resistance elements that are designed for all types of electric heated industrial furnaces.

When we introduced the now world-famous Kanthal iron-chromium-aluminum electric resistance alloys in the early thirties this represented a considerable rise in the maximum operating temperature of metallic resistance elements.

Again, when Kanthal Super molybdenum disilicide (MoSi$_2$) heating elements were introduced in 1956, this represented a step upwards on the temperature scale for resistance elements.

Our aim has always been to constantly improve our materials to enable their use at still higher temperatures. Through intense research work, we have been able to raise this temperature from 1650°C (3000°F) element temperature in 1956, to 1850°C (3360°F) today.

Kanthal Super elements have proved to be very useful not only at high furnace temperatures, but also at lower temperatures, particularly in the field of heat treatment of metallic products in controlled atmospheres and melting of glass.

The fields of possible applications are virtually unlimited and have yet to be fully explored. With the increasing interest in electric heating, we can expect many new designs and applications in the future.

In addition to information on the properties of our Kanthal Super material this handbook will also provide data on our standard elements and instructions for element installation, operation, etc. Further, advice is given on furnace designs, and examples of actual Kanthal Super element installations are shown in the installation section.

The information provided in this handbook enables you to calculate and install the Kanthal Super elements and operate your furnaces. Following the instructions you will get an efficient and economical installation of our equipment in your heat treatment operations.

To get in contact with your local representative for further information, please visit www.kanthal.com or show this QR-code to your smartphone.

SPECIAL FEATURES

- Kanthal Super heating elements may be used in an oxidizing atmosphere up to an element temperature of 1850°C (3360°F)
- Long life combined with ease of replacing failed elements contributes to a high degree of utilization of the furnace and low maintenance costs
- New and old elements can be connected in series
- High power concentration may be applied
- Can be used continuously or intermittently
- Fast ramping
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## Products and accessories

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Range of Kanthal® Super 6/12, 9/18, 12/24 elements and Superthal™ heating modules.
Kanthal Super is a dense cermet material consisting of molybdenum disilicide (MoSi₂) and an oxide component, mainly a glass phase.

Kanthal Super heating elements have the ability to withstand oxidation at high temperatures. This is due to the formation of a thin and adhesive protective layer of quartz glass on the surface. When MoSi₂ reacts with oxygen in the atmosphere, the layer of quartz glass is formed and under this a thin layer of molybdenum silicide with a lower silicon content Mo₅Si₃.

When Kanthal Super elements are operated at temperatures around 1200°C (2190°F) the material becomes ductile, whilst at lower temperatures the material is more brittle.

The silica layer possesses the capacity to clean itself from adhering impurities. If the impurities react with silica, the melting point will be lowered. The contaminated layer then flows down the element and drops off. A new silica layer is, however, spontaneously rebuilt.

GRADE FOR DEMANDING APPLICATIONS
Kanthal program of MoSi₂ heating element includes several grades with specific features for use in demanding applications and atmospheres.

Kanthal Super 1700
Kanthal Super is a unique material combining the best properties of metallic and ceramic materials. Like metallic materials it has good heat and electrical conductivity and like ceramics it withstands corrosion and oxidation and has low thermal expansion. Maximum temperature 1700°C (3090°F).

Kanthal Super 1800
Same core characteristics as Kanthal Super 1700. Maximum temperature 1800°C (3270°F).

Kanthal Super 1900
Same core characteristics as Kanthal Super 1700, but has higher purity and a surface with better adhesion. Maximum temperature 1850°C (3360°F).

Kanthal Super ER
Kanthal Super ER is a new electric heating element with the unique ability to operate up to 1580°C (2875°F) directly in a wide range of furnace atmospheres from very dry reducing to oxidizing. With Kanthal Super ER heating elements it is possible, in just one furnace, to operate firing cycles where the atmosphere condition can be altered during the cycle between oxidizing, inert, carburizing, nitriding, reducing and rough vacuum.

Kanthal Super RA
Kanthal Super RA offers a long lifetime at high temperature in all reducing and oxygen deficient atmospheres. Specially designed for working in nitrogen atmosphere. Maximum temperature 1700°C (3090°F).

Kanthal Super HT
Kanthal Super HT is designed for a longer lifetime of small dimension elements in temperature cycling conditions. The hot strength and form stability is improved. The maximum operating temperature is 1830°C (3330°F), and the element is suitable for furnace temperatures between 1500–1750°C (2730–3180°F) approximately.
Properties

Kanthal® Super is a unique material combining the best properties of metallic and ceramic materials.

Like metallic materials it has good heat and electric conductivity and like ceramics it withstands corrosion and oxidation and has a low thermal expansion.

It is not affected by thermal shock and is strong enough to withstand many years of service as a heating element.

**RESISTIVITY**
The resistivity of Kanthal® Super increases sharply with temperature. This means that when the elements are connected to a constant voltage, the power will be higher at lower temperatures and will be gradually reduced with increasing temperature, thus shortening the time for the furnace to reach operating temperature. Furthermore, as the power of the elements decreases, the danger of overheating will be reduced.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Max. element temperature</td>
<td>1580°C (2875°F)</td>
<td>1700°C (3090°F)</td>
<td>1700°C (3090°F)</td>
<td>1800°C (3270°F)</td>
<td>1830°C (3330°F)</td>
<td>1850°C (3360°F)</td>
</tr>
</tbody>
</table>

The mechanical and physical properties of Kanthal® Super

<table>
<thead>
<tr>
<th>Property</th>
<th>Kanthal® Super ER</th>
<th>Kanthal® Super HT</th>
<th>Other Kanthal Super</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength at 1550°C (2820°F)</td>
<td>–</td>
<td>100 MPa ± 25%</td>
<td>100 MPa ± 25%</td>
</tr>
<tr>
<td>Bending strength at 20°C (68°F)</td>
<td>450 MPa ± 10%</td>
<td>350–400 MPa ± 10%</td>
<td>450 MPa ± 10%</td>
</tr>
<tr>
<td>Compression strength at 20°C (68°F)</td>
<td>1400–1500 MPa</td>
<td>1400–1500 MPa</td>
<td>1400–1500 MPa</td>
</tr>
<tr>
<td>Fracture toughness, KIC, at 20°C (68°F)</td>
<td>3–4 MPam¹/²</td>
<td>4 MPam¹/²</td>
<td>3–4 MPam¹/²</td>
</tr>
<tr>
<td>Hardness, HV, at 20°C (68°F)</td>
<td>9 GPa</td>
<td>8 GPa</td>
<td>9 GPa</td>
</tr>
<tr>
<td>Density</td>
<td>5.6 g/cm³</td>
<td>7.0 g/cm³</td>
<td>6.5 g/cm³</td>
</tr>
<tr>
<td>Porosity</td>
<td>&lt; 5%</td>
<td>&lt; 1%</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Thermal conductivity 20–600°C (68–1110°F)</td>
<td>30 Wm⁻¹ K⁻¹</td>
<td>30 Wm⁻¹ K⁻¹</td>
<td>30 Wm⁻¹ K⁻¹</td>
</tr>
<tr>
<td></td>
<td>15 Wm⁻¹ K⁻¹</td>
<td>15 Wm⁻¹ K⁻¹</td>
<td>15 Wm⁻¹ K⁻¹</td>
</tr>
<tr>
<td>Coefficient of linear expansion</td>
<td>7–8 × 10⁻⁴ K⁻¹</td>
<td>7–8 × 10⁻⁴ K⁻¹</td>
<td>7–8 × 10⁻⁴ K⁻¹</td>
</tr>
<tr>
<td>Specific heat capacity at 20°C (68°F)</td>
<td>0.42 kJ kg⁻¹ K⁻¹</td>
<td>0.42 kJ kg⁻¹ K⁻¹</td>
<td>0.42 kJ kg⁻¹ K⁻¹</td>
</tr>
<tr>
<td>Emissivity</td>
<td>0.75–0.85</td>
<td>0.70–0.80</td>
<td>0.70–0.80</td>
</tr>
<tr>
<td>Resistivity as a function of temperature</td>
<td>See page 8, diagram “Resistivity for Kanthal® Super”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The resistance of Kanthal® Super elements does not change due to ageing even after having been in operation for a long time at high temperatures. There is only a slight reduction (≈ 5%) during the first period of time.

Due to these properties a failed element can easily be replaced without the performance of other elements connected in series being influenced.

See page 8, diagram “Resistivity for Kanthal® Super”.
Chemical resistance

Atmospheres
Kanthal® Super can be used in most furnace atmospheres. Most favorable are oxidizing atmospheres such as air, carbon dioxide and water vapor, but Kanthal Super elements are also operating successfully in neutral, reducing and carburizing atmospheres.

The diagram below indicates the maximum recommended element temperatures in some common types of furnace atmospheres and gases.

Air
At low temperatures, an oxidation of molybdenum and silicon on the surface of the elements can occur at temperatures around 500°C (930°F). The oxidation product is a yellowish powder, MoO₃ and has normally no detrimental effect on the performance of Kanthal Super elements.

Water vapor and carbon dioxide
Water vapor and carbon dioxide in any amount in the atmosphere have an oxidizing effect. The presence of water vapor in a controlled atmosphere increases the maximum permissible operating temperature.

Sulphur dioxide
This gas sometimes occurs as an impurity in the atmosphere. It normally has no harmful effect on Kanthal Super elements.

Endogas
A typical gas composition is: 20% CO, 40% H₂ and balance N₂. Since hydrogen is present in this gas composition, the dew point and gas velocity are important for determining the maximum temperature. A heating solution with Kanthal Super ER is recommended.

Carburizing atmosphere
Kanthal Super elements are widely used in carburizing furnaces. The elements are not attacked by the atmosphere which normally consists of an endogas or nitrogen with controlled additions of a carburizing gas such as propane or methanol.

In this type of furnace, the element temperature is normally kept below 1400°C (2550°F). If carbon is built up in the furnace because of high carbon potential, it can lead to element failure. Regular removal of the carbon by firing the furnace under oxidizing conditions is recommended.

Nitrogen atmosphere
Nitrogen is used for different purposes such as:
- Nitration of ceramics (reaction)
- Protective gas
- Balancing furnace atmospheres

In the element temperature range of 1250–1550°C (2280–2820°F), nitration of ceramics usually occurs. At such temperatures, when the protective glaze is consumed, silicon in the silicide of the element may react with nitrogen forming silicon nitride (Si₃N₄), which could damage the element by scaling. The elements to be used for this purpose should be specially heat treated by Kanthal in order to reduce nitrogen penetration into the material. This treatment is always advisable when operating in nitrogen and when the dew point is low.

With operation below 1250°C (2280°F) element temperature the reaction is minor. Above 1500°C (2820°F) up to 1700–1800°C (3090–3270°F) the performance of the element very much depends on dew point and time at temperature. In cyclic conditions where the time at temperature is short, the oxide layer on elements can be restored by operating for a short time in air.

Maximum recommended element temperature in different atmospheres
When operating for extended periods at temperature (continuous furnaces), the actual formation of a thin layer of Si₃N₄ at the surface of the elements, offers the best protection against further gaseous reaction. When special heat treatment is recommended, it can usually be performed in the furnace where the elements are installed, by operating them in air above 1550°C (2820°F) element temperature for a couple of hours. A heating solution with Kanthal Super RA is recommended when running a continuous operation. When running continuous or cyclic operations, a heating solution with Kanthal Super ER is recommended.

**Noble gases, argon and helium**

These gases are inert and do not react chemically with Kanthal Super. However, if there is a gas flow around the elements, it will disturb the chemical equilibrium existing around the elements. At high temperatures the glaze is consumed. When using these gases, a regeneration of the glaze is recommended before the old glaze has disappeared completely. A heating solution with Kanthal Super ER is recommended.

**Hydrogen**

In dry hydrogen the silica layer is reduced and MoSi₂ disintegrates by forming gaseous silicon and silicides with lower silicon content. This reaction is dependent on temperature and the reduction potential of the hydrogen gas. By increasing the dew point the maximum permissible element temperature can be increased (see page 6, diagram “Maximum element temperature in hydrogen atmospheres”). Installation of the elements in niches can reduce the gas flow around the elements, and this can help to reduce the chemical attacks. A heating solution with Kanthal Super ER is recommended in dry hydrogen atmosphere.

**Nitrogen and hydrogen**

The mixture of these gases should be considered as hydrogen. Although nitrogen reduces the reactivity of hydrogen, the effect of hydrogen is considerable, especially with extended periods in operation. The dew point of the gas mixture and the gas velocity are always very important (see page 6, diagram “Maximum element temperature in hydrogen atmospheres”). Special heat treatment will improve the performance. A heating solution with Kanthal Super ER is recommended.

**Fluorine and chlorine**

These halogens attack Kanthal Super strongly, even oxidized elements, already at temperatures below 600°C (1110°F). Both fluorine and chlorine can be formed by dissociation of organic compounds, which may often enter the furnace together with unclean products.

**Vacuum**

Kanthal Super elements are not suitable for operation in a high vacuum at high temperatures due to silica vaporization. (Page 6, diagram “Maximum element temperature in vacuum”) shows the maximum permissible element temperatures at different air pressures. A heating solution with Kanthal Super ER is recommended.

** Metals**

All metals in direct contact with Kanthal Super react with MoSi₂, forming silicides. At higher furnace temperatures, vapors from molten metal, (zinc, copper, bronze) may also attack the elements. Dust from metal oxides in the furnace atmosphere reacts with the glaze. It is also important that the elements are protected from splashes of molten metal. Any metal or alloy with a melting point lower than approximately 1300°C (2370°F) may be melted in a Kanthal Super furnace if necessary precautions are taken. In small crucible furnaces where the elements are protected from metal fumes approx. 1550°C (2820°F) is possible.

**Alkali**

Compounds such as K₂O and Na₂O in the furnace atmosphere will act as a fluxing agent on the silica layer and attack the elements. Their salts also attack elements which may occur in glass melting furnaces.

The choice of lining material for furnaces operating at temperatures above 1550 – 1600°C (2820 – 2910°F) in particular is very important. Castables always contain alkalis. Due to how these are chemically bound in the castable they could be more or less aggressive to the Kanthal Super elements.

Avoid castables containing alkali above 1550 – 1600°C (2820 – 2910°F) furnace temperature.

**Ceramics**

As the operating temperature of Kanthal Super elements is normally rather high, reactions can easily take place between the silica layer on the element surface and most salts and oxides. This is of particular importance when the elements are supported by ceramics. The ceramics in these cases must consist of stable compounds, silicates, which do not react with silica. Suitable ceramics are silimanite and mullite. At element temperatures exceeding 1600°C (2910°F) reactions can nevertheless occur. This element temperature should not be exceeded when the element rests on a ceramic support.

**Firing of ceramics**

Green ceramics (before firing) contain binders or similar, which during firing fume off, developing residual products. These residual products must be removed in order to minimize the contamination of furnace atmosphere and walls. At higher element temperatures, these residual products may attack the elements.

**Glass**

The atmosphere in a glass furnace normally has a slightly fluxing effect on the silica layer, thus lowering the viscosity and causing the glaze to flow slowly down the element. However, this normally has no detrimental effect on the life of the element.
Maximum element temperature in hydrogen atmospheres

Element temperature, °C Element temperature, °F

-80 -60 -40 -20 0 +20 +40 °C
-112 -76 -40 -4 +32 +68 +104 °F

-112 -76 -40 -4 +32 +68 +104 °F

Dew point

Kanthal® Super ER in 100% H₂  All other Kanthal Super in 100% H₂

Maximum element temperatures in vacuum

Element temperature, °C Element temperature, °F

-80 -60 -40 -20 0 +20 +40 °C
-112 -76 -40 -4 +32 +68 +104 °F

0.013 0.13 1.33 13.33 133.3 1333 13330 Torr

Kanthal® Super ER  All other Kanthal Super
Performance

TEMPERATURE DEPENDENCE OF RESISTIVITY
The diagram on page 8 shows that the resistivity of Kanthal® Super increases sharply with temperature.

ELEMENT SURFACE LOAD
The curves shown in the diagrams on page 9, which apply to furnaces with suspended, freely radiating Kanthal Super elements show the approximate element temperature at various furnace temperatures, element surface loads and currents.

For example, at an element surface load of 14.4 W/cm² (92.9 W/in²) and a furnace temperature of 1300°C (2370°F) the element temperature of Kanthal Super 1700 will be 1525°C (2780°F) with a current of 156 A for 6 mm Ø and 286 A for 9 mm Ø.

WALL LOADING
A characteristic property of furnaces equipped with Kanthal Super elements is that the surface load on the furnace walls can be much higher than with metallic elements. This is due to the high maximum operating temperature of the Kanthal Super elements. Consequently, the heating-up time can be considerably reduced.

The wall loading is also dependent on how the elements are installed: along the walls or perpendicular.

The diagrams on page 10 shows maximum recommended wall loading as a function of the furnace temperature for different element diameters and mode of installation.
**Resistivity of Kanthal® Super**

Resistivity, Ω mm²/m

\[ r = \frac{\rho \times l \times 4}{\pi \times d^2} \]

- \( r \) = resistance, Ω/m
- \( \rho \) = from diagram
- \( l \) = rod length, m
- \( d \) = diameter, mm

**OXIDE GROWTH**

For Kanthal Super grades the oxide growth at certain temperature as function of time have a parabolic growth. The growth of the oxide layer, the glaze, of Kanthal Super HT is much reduced, compared to Kanthal Super 1800 and 1900, see diagram below. A thin oxide layer results in a much-improved service life, because the tension is reduced between the base material and the surrounding oxide, depending on the different thermal expansion coefficient.

**Oxidation properties**

Oxide thickness, μm
Maximum recommended wall loading as a function of the furnace temperature for different element diameters and mode of installation

Element diameter: 6/12  9/18  12/24
NECESSARY DISTANCES

Distance to wall
It is important that the distance between wall and heating zone of the element is large enough to avoid contact. In the case of long elements at high temperatures, electromagnetic forces and bad centering when installing the elements may cause the elements to come in contact with the walls, causing damage.

The minimum distance, e, between the heating zone of the element and the furnace walls depends on the length of the element (see the figures to the right).

When installed along the wall it is:
- For \( L_e < 1000 \text{ mm} \) (39.4 in); \( e = L_e / 20 \)
- For \( L_e < 300 \text{ mm} \); \( e = \text{min. } 15 \text{ mm} \) (0.6 in)
- For \( L_e > 1000 \text{ mm} \) (39.4 in); \( e = \text{min. } 50 \text{ mm} \) (1.97 in)

When installed perpendicular to the wall, the deformation due to the electromagnetic forces must also be considered. The reason is that the deformation causes reduction of the distance between part of the heating zone and the wall. After calculating the magnitude of deformation (see the figure on page 12 “Deformation of Kanthal® Super elements”), the distance \( E \) can be calculated and \( e \) is estimated in the same way as for elements installed parallel to the wall.

\[ E_{\text{min}} = e + \frac{A - a}{2} \]

Distance to bottom
In order to prevent the elements from coming into contact with any material deposited on the bottom of the furnace and to compensate for the elongation of the elements at high temperatures, the recommended vertical distance \( h \) between the element bend and the furnace floor should be at least:

\[ h \geq \frac{L_e}{20} \text{; min. } 10 \text{ mm} \]

Distance between elements
Minimum distances, \( b \), between adjacent elements are given in the figure on page 12 “Necessary distances”.

Installation parameters.
The minimum length of opening A is calculated according to the diagram above.
Elements and tubes

The most commonly used design is a two-shank U-shaped element (fig. 1, page 14). The heating zone is welded to terminals which normally have a diameter double that of the heating zone.

The two-shank element can be bent 45° or 90° either in the heating zone or in the terminals (fig. 2–5, pages 14–15).

Four-shank elements are used only horizontally (fig. 5).
Kanthal Super is also available as a Superthal™ heating unit.

TWO-SHANK ELEMENTS
Two-shank elements with straight terminals are defined by:
• The quality
• Heating zone diameter, mm (in)
• Terminal diameter, mm (in)
• Terminal length, Lu, mm (in)
• Heating zone length, Le, mm (in)
• Center distance between shanks, a, mm (in)

Example:
Kanthal Super 1700 9/18  Lu = 450 mm (17.7 in)
Le = 560 mm (22 in)
a = 60 mm (2.36 in)

The maximum length of the heating zone depends on the element temperature. The diagram on page 16, “Maximum recommended heating zone lengths”, shows the maximum recommended heating zone lengths for vertically suspended 6/12, 9/18 and 12/24 elements.

* Note: 3/6 and 4/9 mm Kanthal Super 1800 elements are not normally manufactured with a heating zone Le longer than 400 mm (15.8 in).

Two-shank bent elements
Bent elements are used when the electrical connections for some reason cannot be made above the roof. When the furnace is too high to permit installation of elements suspended from the roof, due to the limitation regarding the maximum permitted heating zone length, it may also be necessary to install elements with bent terminals or heating zones. By installing several rows of such elements it is also possible to control the power at different levels in the furnace.

The terminals are supported by brick or fiber, which normally limits the maximum temperature to 1600°C (2910°F) furnace temperature.

FOUR-SHANK ELEMENTS
Four-shank Kanthal Super 1700 elements for horizontal use
In many cases, particularly in furnaces with a low chamber height, the best choice is horizontally mounted elements.

The advantage of this shape is that fewer elements are needed than in the case of two-shank elements, with lower terminal losses, making the four-shank elements more economical. Maximum element temperature 1600°C (2910°F). Available as 6/12, 9/18 and 12/24 elements.

Four-shank elements with straight terminals (fig. 5, page 15) are defined by:
• The quality
• Heating zone diameter, mm
• Terminal diameter, mm
• Terminal length, Lu, mm (in)
• Heating zone length, Lh, mm (in)
• Heating zone length, B, mm (in)
• Center distances between shanks, a, mm (in)

Example:
Kanthal Super 1700 9/18  Lh = 450 mm (17.7 in)
Le = 450 mm (17.7 in)
B = 400 mm (15.8 in)
a = 3 × 60 mm (3 × 2.36 in)

Range of Kanthal Super elements

<table>
<thead>
<tr>
<th>Grade</th>
<th>Element size, mm</th>
<th>heating zone diameter/terminal diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/6</td>
<td>4/9</td>
</tr>
<tr>
<td>Kanthal® Super 1700</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Kanthal Super 1800</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Kanthal Super 1900</td>
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<tr>
<td>Kanthal Super RA</td>
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<tr>
<td>Kanthal Super ER</td>
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<td>•</td>
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<tr>
<td>Kanthal Super HT</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>

* 9/12/18
### Terminal shapes

![Diagram of straight terminals](image1.png)

![Diagram of element bent 90° at the terminals](image2.png)

**The following parameters are valid for all Kanthal® Super elements (metric)**

<table>
<thead>
<tr>
<th>Element size</th>
<th>a, mm</th>
<th>c, mm</th>
<th>d, mm</th>
<th>f, mm</th>
<th>g, mm</th>
<th>k₉₀°, mm</th>
<th>k₄₅°, mm</th>
<th>m, mm</th>
<th>n, mm</th>
<th>r, mm</th>
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</thead>
<tbody>
<tr>
<td>3/6</td>
<td>25</td>
<td>16</td>
<td>6</td>
<td>3</td>
<td>25</td>
<td>15</td>
<td>9</td>
<td>30</td>
<td>42</td>
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</tr>
<tr>
<td>4/9</td>
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<td>15</td>
<td>9</td>
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<tr>
<td>6/12</td>
<td>50</td>
<td>26</td>
<td>12</td>
<td>6</td>
<td>45</td>
<td>25</td>
<td>9</td>
<td>60</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>9/18</td>
<td>60</td>
<td>38</td>
<td>18</td>
<td>9</td>
<td>75</td>
<td>30</td>
<td>35</td>
<td>90</td>
<td>135</td>
<td>100</td>
</tr>
<tr>
<td>12/24</td>
<td>80</td>
<td>54</td>
<td>24</td>
<td>12</td>
<td>100</td>
<td>40</td>
<td></td>
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<td></td>
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</tbody>
</table>

Dimensional tolerances ± 5% (except c and d)

### The following parameters are valid for all Kanthal Super elements (imperial)

<table>
<thead>
<tr>
<th>Element size</th>
<th>a, in</th>
<th>c, in</th>
<th>d, in</th>
<th>f, in</th>
<th>g, in</th>
<th>k₉₀°, in</th>
<th>k₄₅°, in</th>
<th>m, in</th>
<th>n, in</th>
<th>r, in</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/6</td>
<td>0.98</td>
<td>0.63</td>
<td>0.24</td>
<td>0.12</td>
<td>0.98</td>
<td>0.59</td>
<td>0.75</td>
<td>0.35</td>
<td>1.18</td>
<td>1.65</td>
</tr>
<tr>
<td>4/9</td>
<td>0.98</td>
<td>0.75</td>
<td>0.35</td>
<td>0.16</td>
<td>0.98</td>
<td>0.59</td>
<td>0.75</td>
<td>0.35</td>
<td>1.38</td>
<td>1.85</td>
</tr>
<tr>
<td>6/12</td>
<td>1.97</td>
<td>1.02</td>
<td>0.47</td>
<td>0.24</td>
<td>1.77</td>
<td>0.98</td>
<td>1.85</td>
<td>0.94</td>
<td>2.36</td>
<td>3.55</td>
</tr>
<tr>
<td>9/18</td>
<td>2.36</td>
<td>1.50</td>
<td>0.71</td>
<td>0.35</td>
<td>2.95</td>
<td>1.18</td>
<td>2.80</td>
<td>1.38</td>
<td>3.71</td>
<td>5.31</td>
</tr>
<tr>
<td>12/24</td>
<td>3.15</td>
<td>2.13</td>
<td>0.95</td>
<td>0.47</td>
<td>3.94</td>
<td>1.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dimensional tolerances ± 5% (except c and d)
h = 15 mm (0.59 in) 6/12
20 mm (0.79 in) 9/18
30 mm (1.18 in) 12/24

$L_e = L_e - 9$ mm (0.35 in) 6/12
- 11 mm (0.43 in) 9/18
- 21 mm (0.83 in) 12/24

Fig. 3 Element bent 90°.

Fig. 4 Element bent 45° at the terminals.

Fig. 5 Four-shank element for horizontal use.
Maximum recommended heating zone lengths for vertically suspended 6/12, 9/18 and 12/24 mm elements
**TUBES**

Tubes are normally manufactured in a quality corresponding to Kanthal® Super 1700. As the same material is used in the tubes as in the elements the data regarding properties previously given in the handbook is also valid for tubes. Standard sizes are manufactured as per table to the right.

**Maximum lengths**

For outer diameter 7–25 mm (0.28 – 0.98 in) maximum 2000 mm (78.7 in).

**Kanthal Super bubble tubes**

The standard Kanthal Super bubbler tube has an ID of 3 mm (0.12 in) and OD 12 mm (0.47 in). Some glass works inquire smaller end holes for generation of smaller air bubbles.

Kanthal can now supply 12/3 tubes with a 5 mm (0.20 in) welded end cap with a min 0.7 mm (0.03 in) hole made by water jet.

---

<table>
<thead>
<tr>
<th>Outside diameter ± 5%</th>
<th>Inside diameter ± 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>in</td>
</tr>
<tr>
<td>12</td>
<td>0.47</td>
</tr>
<tr>
<td>12</td>
<td>0.47</td>
</tr>
<tr>
<td>22</td>
<td>0.87</td>
</tr>
<tr>
<td>25</td>
<td>0.98</td>
</tr>
</tbody>
</table>

**Examples of applications for Kanthal Super tubes**

- Protection tubes for thermocouples.
- Bubbler tubes for glass melting.
- Tubes for electrodes for glass melting.
Accessories

ELEMENT SIZE 3/6 MM AND 4/9 MM
Contact straps

**Type 5826**
Lengths (L): 100, 150, 200

**Type 5827**
Lengths (L): 75, 100, 150, 200

**Type 5828**
Lengths (L): 75, 100, 150, 200

**Type 5829**
Lengths (L): 75, 100, 150, 200
Spring clips to be used at both ends.
Spring clips

Type 10434
for element size 3/6 mm

Type 10435
for element size 4/9 mm

Element holder

Type 5830

Single-shank holders

Type 10421
for element size 3/6 mm

Type 10424
for element size 4/9 mm
ELEMENT SIZE 6/12 MM
Contact straps

**Type 5766**
Lengths (L): 80, 100, 150, 200, 250, 300

**Type 3579**
Lengths (L): 80, 100, 150, 200, 250, 300

**Type 5768**
Lengths (L): 150, 200, 250, 300
Note: Two pcs per shank for 9/18

Contact clamp

**Type 5758**

Expansion tool for clamps

**Type 21690**
Single-shank holders

Type 6248

Type 5778

Two-shank holder

Type 5776

a = 40, 45, 50, 55, 60
ELEMENT SIZE 9/18 MM
Contact straps

Type 3801
Lengths (L): 100, 150, 200, 250, 300

Single-shank holders

Type 6249

Type 5779

Two-shank holders

Type 5776
\(a = 40, 45, 50, 55, 60\)

Type 5777
\(a = 80\) and 150 for element size 6/12 also
ELEMENT SIZE 12/24 MM
Contact straps

**Type 10432**
Lengths (L): 150, 200, 250, 300
Note: Two per shank

**Type 10439**

---

**Single-shank holder**

**Type 10433**

---

**Two-shank holders**

**Type 10437**
\( a = 60 \)

**Type 10438**
\( a = 80 \)
ANCHOR SYSTEMS

Standard anchor system

**Type 5987**
Element holder
Standard design

Air cooled anchor system

**Type 5927**
Element holder with air nozzle for Kanthal® Super 9/18 mm $a = 60$

**Type 6031**
Element holder for Kanthal Super 6/12 mm $a = 50$

**Type 6033**
Element holder for Kanthal Super 6/12 mm $a = 40$
**Sealed element anchor system**

**Type 5965**
Element holder with sealed terminal lead through for Kanthal Super 9/18 mm $a = 60$

**Type 6037**
Element holder with sealed terminal lead through for Kanthal Super 6/12 mm $a = 50$

**Graphite alternative**
### PASSAGE BRICKS

*Note:* Under certain conditions, long passage bricks may result in excessive temperatures on the terminals, unless special precautions are taken when designing the furnace.

**For anchor systems, sealed design**

**Type 6038**
for 6/12 mm

**Type 5984**
for 9/18 mm

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Grade</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>a</th>
<th>d</th>
<th>Element size</th>
</tr>
</thead>
<tbody>
<tr>
<td>6038-1</td>
<td>28</td>
<td>115</td>
<td>64</td>
<td>229</td>
<td>50</td>
<td>15</td>
<td>6/12</td>
</tr>
<tr>
<td>5984-1</td>
<td>28</td>
<td>115</td>
<td>64</td>
<td>229</td>
<td>60</td>
<td>23</td>
<td>9/18</td>
</tr>
<tr>
<td>5984-2</td>
<td>28</td>
<td>115</td>
<td>76</td>
<td>229</td>
<td>60</td>
<td>23</td>
<td>9/18</td>
</tr>
<tr>
<td>5984-3</td>
<td>28</td>
<td>152</td>
<td>76</td>
<td>305</td>
<td>60</td>
<td>23</td>
<td>9/18</td>
</tr>
</tbody>
</table>

**For anchor systems, typical design**

**Type 6036**
for 6/12 mm

**Type 5985**
for 9/18 mm

**Type 10943**
for 12/24

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Grade</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>a</th>
<th>d</th>
<th>D</th>
<th>Element size</th>
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<td>115</td>
<td>64</td>
<td>229</td>
<td>40</td>
<td>15</td>
<td>25</td>
<td>6/12</td>
</tr>
<tr>
<td>6036-9,-4,-8</td>
<td>G28,30,33</td>
<td>115</td>
<td>64</td>
<td>229</td>
<td>45</td>
<td>15</td>
<td>25</td>
<td>6/12</td>
</tr>
<tr>
<td>6036-2,-5,-7</td>
<td>G28,30,33</td>
<td>115</td>
<td>64</td>
<td>229</td>
<td>50</td>
<td>15</td>
<td>25</td>
<td>6/12</td>
</tr>
<tr>
<td>5985-1,-4,-8</td>
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<td>115</td>
<td>64</td>
<td>229</td>
<td>60</td>
<td>23</td>
<td>35</td>
<td>9/18</td>
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<tr>
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<td>229</td>
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<td>23</td>
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<td>9/18</td>
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<td>76</td>
<td>305</td>
<td>60</td>
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<td>9/18</td>
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<td>10943-1,-4,-7</td>
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<td>115</td>
<td>64</td>
<td>229</td>
<td>60</td>
<td>30</td>
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<td>12/24</td>
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<td>76</td>
<td>229</td>
<td>60</td>
<td>30</td>
<td>40</td>
<td>12/24</td>
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<td>10943-3,-6,-9</td>
<td>G28,30,33</td>
<td>152</td>
<td>76</td>
<td>305</td>
<td>80</td>
<td>30</td>
<td>40</td>
<td>12/24</td>
</tr>
</tbody>
</table>
For anchor systems, air cooled design

**Type 6035**
for 6/12 mm

**Type 5930**
for 9/18 mm

for 12/24 mm

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Grade</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>a</th>
<th>d</th>
<th>D</th>
<th>Element size</th>
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<td>6/12</td>
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<td>6035-2, -5, -8</td>
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<td>64</td>
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<td>50</td>
<td>15</td>
<td>25</td>
<td>6/12</td>
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<tr>
<td>5930-1, -4, -7</td>
<td>G28,30,33</td>
<td>115</td>
<td>64</td>
<td>229</td>
<td>60</td>
<td>23</td>
<td>35</td>
<td>9/18</td>
</tr>
<tr>
<td>5930-2, -5, -8</td>
<td>G28,30,33</td>
<td>115</td>
<td>76</td>
<td>229</td>
<td>60</td>
<td>23</td>
<td>35</td>
<td>9/18</td>
</tr>
<tr>
<td>5930-3, -6, -9</td>
<td>G28,30,33</td>
<td>152</td>
<td>76</td>
<td>305</td>
<td>60</td>
<td>23</td>
<td>35</td>
<td>9/18</td>
</tr>
</tbody>
</table>

Bottom plate: Alfrax coated grade 33
OTHER ACCESSORIES

Steatite rings

Silica cord and graphite cord

<table>
<thead>
<tr>
<th>Element size</th>
<th>6/12</th>
<th>9/18</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>20</td>
<td>27</td>
</tr>
<tr>
<td>d</td>
<td>13</td>
<td>19</td>
</tr>
</tbody>
</table>

Length of silica cord | \(2 \times 180\) | \(2 \times 230\) |
Length of graphite cord | \(4 \times 60\) | \(4 \times 80\) |

| Plates |

Gasket for plates

<table>
<thead>
<tr>
<th>Type</th>
<th>A</th>
<th>B</th>
<th>a</th>
<th>d</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>5986-1</td>
<td>150</td>
<td>150</td>
<td>60</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>5986-2</td>
<td>160</td>
<td>160</td>
<td>60</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>5986-3</td>
<td>180</td>
<td>180</td>
<td>60</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>5986-4</td>
<td>160</td>
<td>200</td>
<td>60</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>5986-5</td>
<td>130</td>
<td>180</td>
<td>60</td>
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<td>28</td>
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<tr>
<td>5986-10</td>
<td>150</td>
<td>150</td>
<td>50</td>
<td>13</td>
<td>21</td>
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</table>

<table>
<thead>
<tr>
<th>Graphite</th>
<th>Ceramic fiber</th>
<th>A</th>
<th>B</th>
<th>a</th>
<th>d</th>
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<tbody>
<tr>
<td>10436-1</td>
<td>5953-1</td>
<td>150</td>
<td>150</td>
<td>60</td>
<td>18</td>
</tr>
<tr>
<td>10436-2</td>
<td>5953-2</td>
<td>160</td>
<td>160</td>
<td>60</td>
<td>18</td>
</tr>
<tr>
<td>10436-3</td>
<td>5953-3</td>
<td>180</td>
<td>180</td>
<td>60</td>
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<tr>
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<td>5953-4</td>
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<td>200</td>
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<tr>
<td>10436-5</td>
<td>5953-5</td>
<td>130</td>
<td>180</td>
<td>60</td>
<td>18</td>
</tr>
<tr>
<td>10436-10</td>
<td>5953-10</td>
<td>150</td>
<td>150</td>
<td>50</td>
<td>12</td>
</tr>
</tbody>
</table>

| 10436-1-5 | d = 30 mm |
| 10436-10  | d = 24 mm |
**Air nozzles**

- **Element size 6/12**: 9/18
- Upper gasket: 11 32 17 38
- Lower gasket: 16 36 22 42

---

**Type**
- **5887-A**: 6/12 40 36 13.5
- **5887-B**: 6/12 50 36 13.5
- **5887-C**: 9/18 60 42 19.5

**Anchor pins**

1) Without locking pin.
2) Element size 6/12 mm and distance between shanks (a) = 40 mm

**Silicon rubber hose**

For connection to air nozzles.

---

**Type**
- **5926-1**: Standard and air cooled
- **5926-2**: Sealed
- **5926-3**: Sealed
- **5926-4**: Air cooled

**Fastening yoke**

Type 5925

---

**Gaskets for air nozzles**

- **Element size**
  - 6/12 9/18
- **Element size**
  - Upper gasket: 11 32 17 38
  - Lower gasket: 16 36 22 42
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