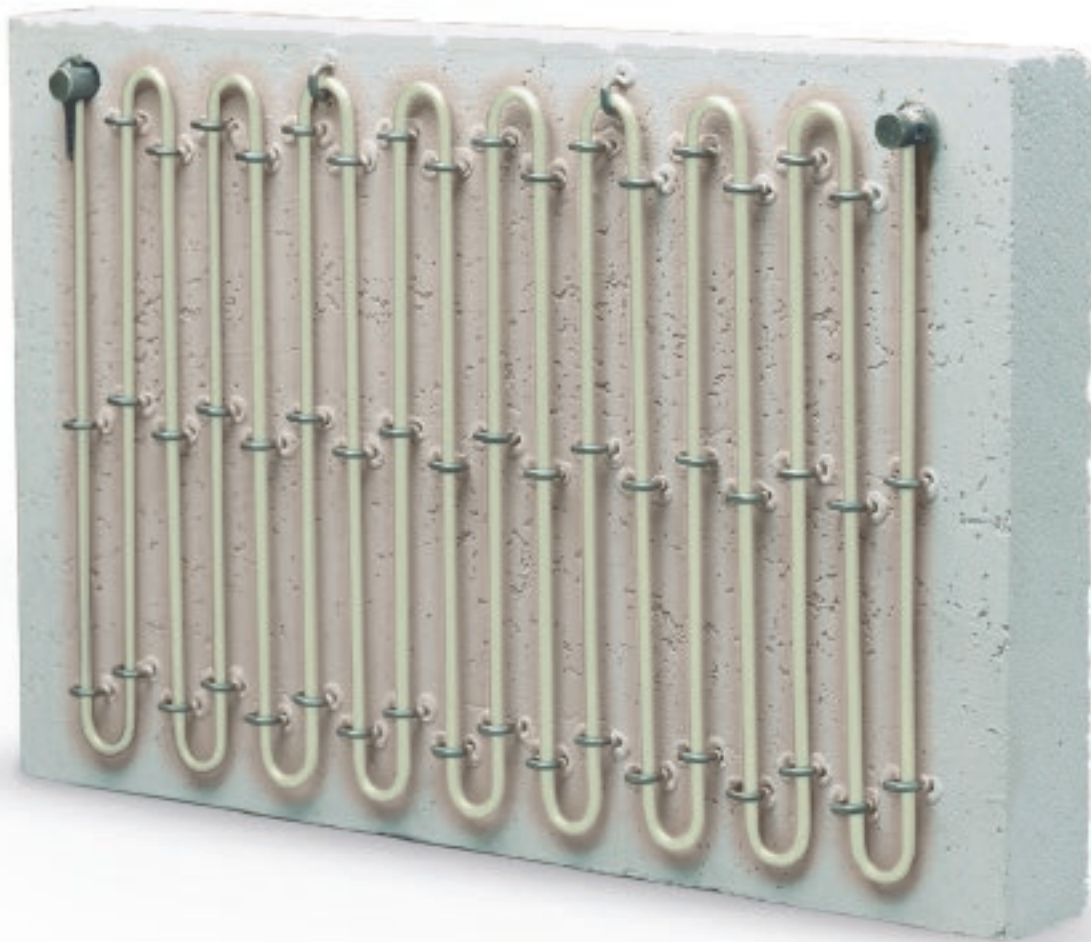


ELECTRIC HEATING MODULES

MODUTHAL[®]



MODUTHAL® HEATING MODULES

Kanthal® is a heating technology brand and we have been in the market since 1931, when our first heating wire was introduced. Today, we offer many types of heating elements and systems for laboratory furnaces, industrial furnaces and processes.

Moduthal® are prefabricated radiant heating modules designed to suit a wide range of thermal processing applications at element temperatures up to 1350°C (2460°F).

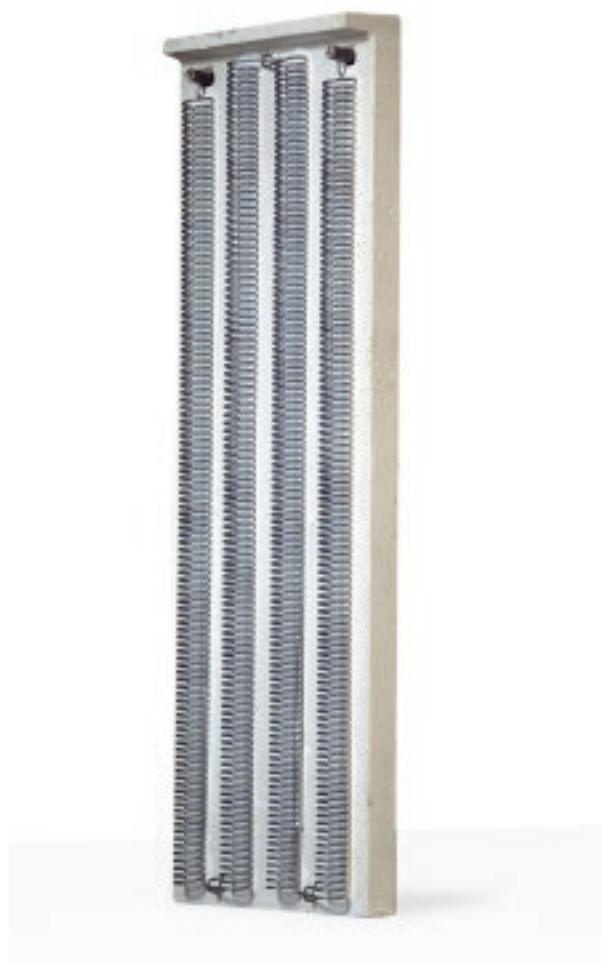
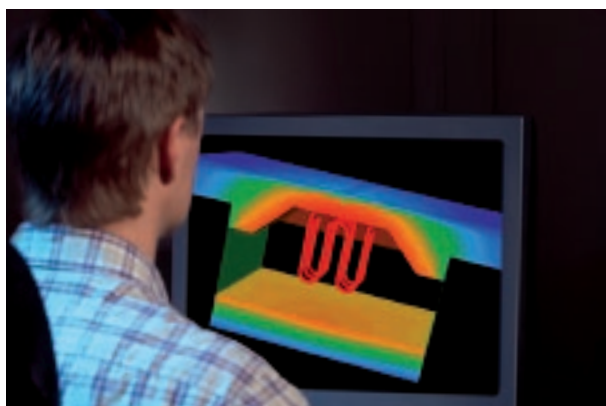
To optimize performance, all resistance material is fabricated primarily from Kanthal® A-1 and Kanthal AF resistance alloys, given each application. The element coils are held in place in a non-electrically conductive, high quality ceramic, to form a Moduthal® heating module.

The elements may be fully embedded, semi-embedded or free radiating. The construction method ensures accurate positioning of the coils and eliminates the distortion or other problems connected to the conventional

open coil elements in grooves or on tubes. A fiber-free version of Moduthal® is available up to 1250°C (2280°F).

The high thermal conductivity of Moduthal® refractory panel acts as a diffuser to distribute heat energy evenly from the elements. This provides improved heat distribution as compared with exposed element coils. To provide sophisticated temperature uniformity within a furnace, multiple zones can be used. Without altering the furnace characteristics, individual units are easily replaced, due to the modular construction.

With the introduction of fully embedded, semi embedded and free radiating elements in Moduthal® heating modules, Kanthal® has taken a major step forward. The exclusive manufacturing process results in e.g. excellent temperature capability, superior element support, and a long life, these being just a few examples of Kanthal® high quality reliable workmanship. The result is a heating module which possesses many features.





FEATURES OF MODUTHAL® HEATING MODULES

- Fully interchangeable modules
- Superior element support
- Long life
- Easy to install
- High surface load
- Excellent heat distribution
- Customized design

LOOK AT KANTHAL AS YOUR PARTNER

We can solve most industrial heating problems from 0 to 2000°C (32 to 3630°F).

THE PROBLEM – FACTS

We collect all the facts and requirements, previous experiences and limitations.

DESIGN AND CALCULATIONS

Our sales engineers analyze the facts, make the basic element and furnace calculations and prepare a preliminary recommendation.

TEST

A prototype is manufactured and tested at one of our technical centers.

SIMULATION

The recommended solution is tested in special, digital simulation programs.

FOLLOW-UP

Our sales engineers keep in touch to monitor and evaluate the system performance.

THE SOLUTION – DELIVERY AND INSTALLATION

We often work as project leader with the responsibility for the whole project including complementary products, like insulation and power supply, training and instruction and the actual installation.

REFERENCE APPLICATIONS

Moduthal® heating modules have been successfully used in these well-established applications.

CRUCIBLE FURNACE

Melting or holding aluminum and copper-based alloys. With the fully embedded type of Moduthal® heating modules some protection is given to the element against metal splashes and fluxes. Moduthal® heating modules permits high wall loadings, gives uniform temperature around the crucible and can be easily replaced.

BILLET HEATING FURNACE

Pre-heating of steel, copper, brass and aluminum billets prior to rolling or forging.

GLASS TOUGHENING AND BENDING FURNACE

Toughening glass for cooker doors and similar products. Operating for an eight-hour day five days per week at 650°C (1200°F) in an air atmosphere.

BRASS MELTING FURNACE

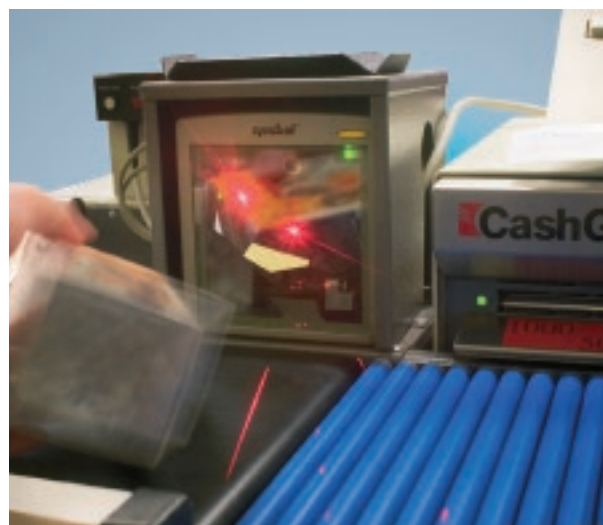
Moduthal® high-temperature panels in roof and walls operating at element temperatures up to 1350°C (2460°F).

TUNDISH PRE-HEATING

For casting aluminum. Moduthal® heating modules gives accurate and even temperature control in a compact design.

WIRE ANNEALING FURNACE

For multi-strand annealing. Moduthal® panels are mounted in the hearth, roof and walls, operating in the range 800–1050°C (1470–1920°F) both continuously and intermittently.



FLUIDIZED BED FURNACE

Interlinked circular muffles (embedded for protection against bed materials) operating typically at 900–1000°C (1650–1830°F).

CRYSTAL GROWING

Low-temperature crystal growing using a Moduthal® heating module at 950–1000°C (1740–1830°F) in air.

BILLET HOLDING FURNACE

Arch-shaped Moduthal® heating module with fully embedded element for billet holding at temperature after induction heating. Intermittent operation at 750–800°C (1380–1470°F).



TYPES AND MAXIMUM TEMPERATURE

Moduthal® cast refractory element modules can be supplied as one of the following individual types of heating module.

MODUTHAL® HEATING MODULE – FULLY EMBEDDED



Maximum element temperature 1100°C (2010°F)

Although being a fully embedded panel, most of the heating element is covered with a thin layer of refractory allowing the element to radiate more efficiently than a standard fully embedded panel. Moduthal® fully embedded heating panels are also available in a fiber free version.

MODUTHAL® HEATING MODULE – SEMI EMBEDDED



Maximum element temperature 1150°C (2100°F)

A conventionally designed panel which offers a cost effective solution to applications that do not require the higher temperatures that can be achieved by the open coil elements in Moduthal® heating module. Moduthal® semi embedded heating panels are also available in a fiber free version.

MODUTHAL® HEATING MODULE – FREE RADIATING



Maximum element temperature 1200°C (2190°F)

Due to the unique Sandvik design, which allows 75% of the heating element to freely radiate, this element is capable of operating up to 1200°C (2190°F). 1150°C (2100°F) when using fiber free modules.

MODUTHAL® HEATING MODULE – FREE RADIATING HIGH TEMPERATURE



Maximum element temperature 1350°C (2460°F)

The unique design of Moduthal® heating modules combines ceramic casting with freely radiating Kanthal® APM material elements. Those elements are capable of operating up to 1350°C (2460°F). 1250°C (2280°F) when using the fiber free modules.

DESIGN

The embedded elements in Moduthal® heating modules can be designed and manufactured in a variety of shapes and sizes and can also include special features such as thermocouple holes, locating lugs and grooves. The elements in Moduthal® heating modules are designed for use in either small furnaces or in multiples to suit larger industrial furnaces or kilns. Each heating panel is typically rated between 1 kW and 10 kW. The mechanical strength of Moduthal® at different temperature is shown in a diagram.

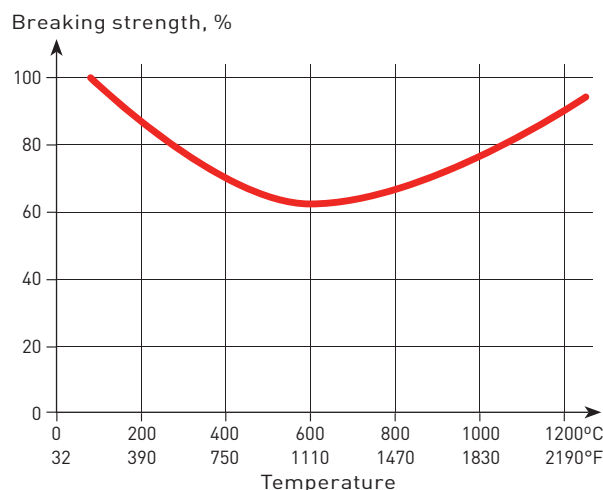
PROCESS ATMOSPHERES

The elements in Moduthal® heating modules are designed to operate in clean air, but may also be used in process atmospheres within the normal limitations of the heating element alloy. The effect of furnace atmospheres is tabulated on page 11.

CONTROL EQUIPMENT

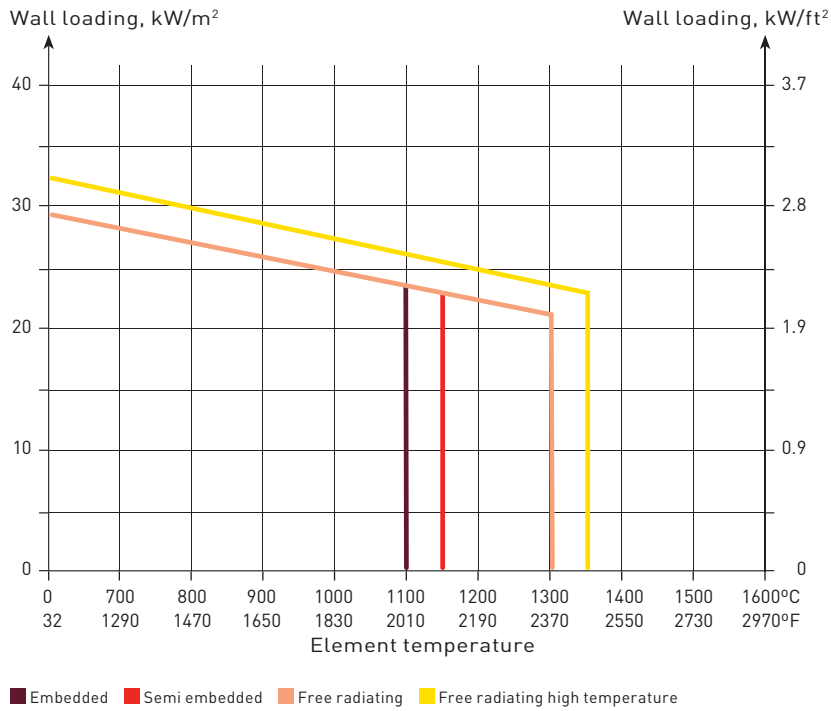
The elements in Moduthal® heating modules are normally operated directly from the mains electricity supply and therefore do not require any special power supply equipment. All modules are highly resistant to thermal stress and there is no need to limit the power input during start up conditions, except during the initial firing up when a slower heating rate may be required to expel any residual moisture.

RESULTS OF LABORATORY TESTS SHOWING THE BREAKING STRENGTH OF MODUTHAL® HEATING MODULES



■ Moduthal®

MAXIMUM RECOMMENDED WALL LOADING VERSUS FURNACE TEMPERATURE FOR VARIOUS TYPES OF MODUTHAL® HEATING MODULES (diagram for guidance only)

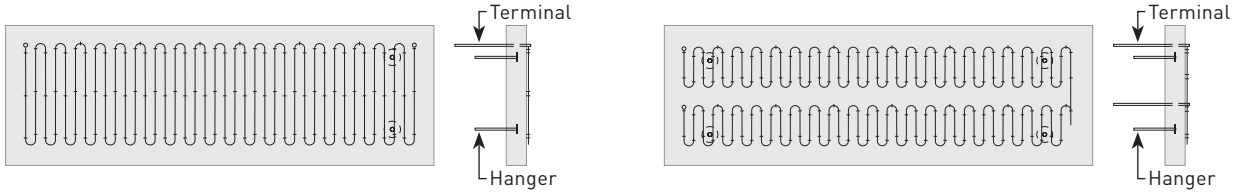


MAXIMUM PERMISSIBLE ELEMENT TEMPERATURES

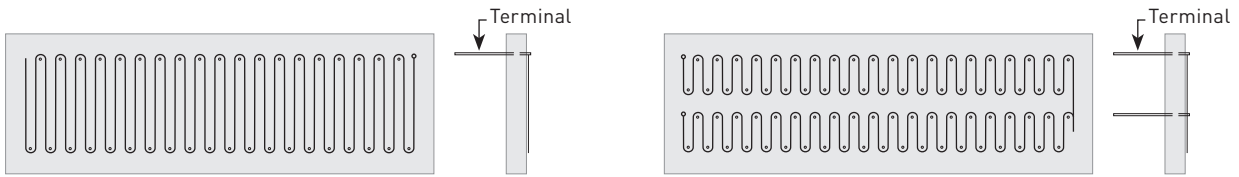
TYPE OF MODULE		MODUTHAL® 3000 MODULE		MODUTHAL® 6000 MODULE		MODUTHAL® FF (FIBER FREE) MODULE	
		°C	°F	°C	°F	°C	°F
Fully embedded (coil)		1100	2010	1100	2010	1100	2010
Semi embedded (coil)		1150	2100	1150	2100	1150	2100
Free radiating (coil)		1200	2190	1200	2190	1150	2100
Free radiating high temperature		1350	2460	1350	2460	1250	2280

COMMON PANEL CONFIGURATIONS

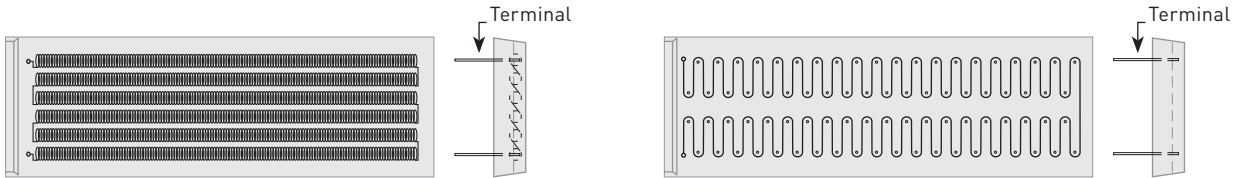
ROOF AND WALL PANELS



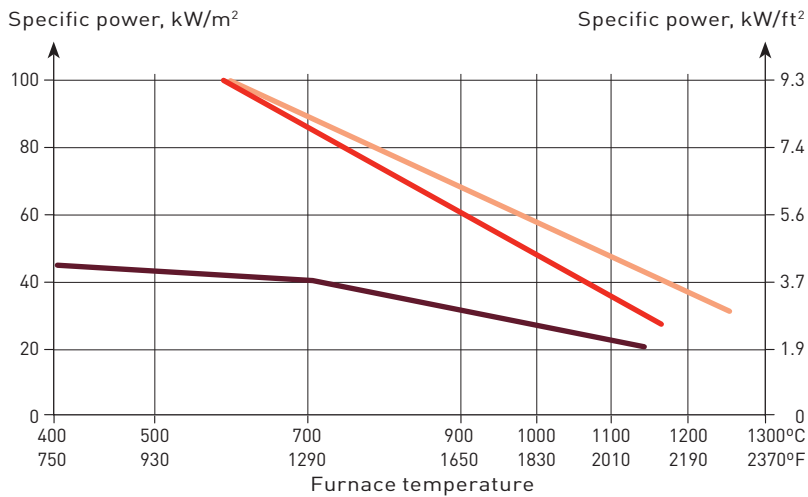
BOTTOM PANELS



PANELS FOR ALUMINUM CRUCIBLE FURNACES



POWER LIMITATION



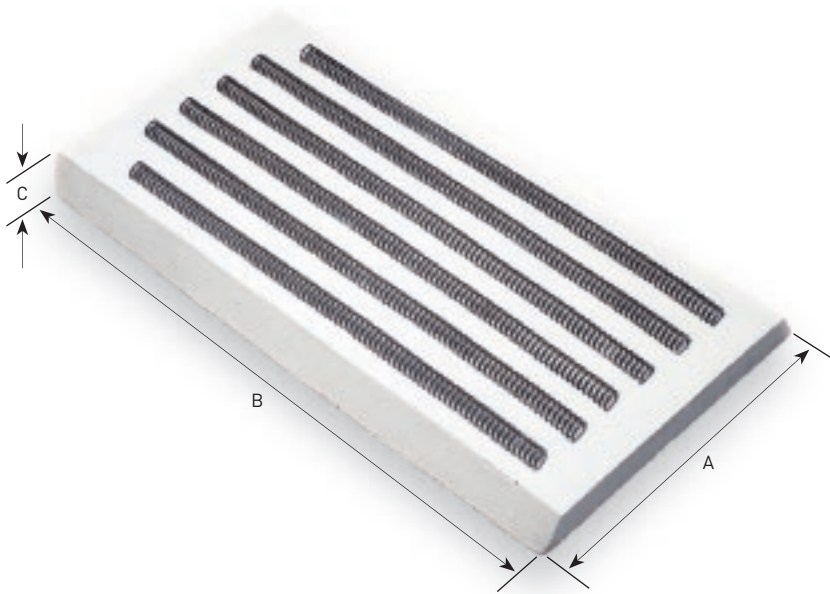
■ Moduthal® 3000, Moduthal® 6000 and Moduthal® FF spiral type
 ■ Moduthal® FF meander type
■ Moduthal® 3000 and Moduthal 6000 meander type

ATMOSPHERES

MAXIMUM PERMISSIBLE ELEMENT TEMPERATURE IN VARIOUS FURNACE ATMOSPHERES

FURNACE ATMOSPHERE	MAX ELEMENT TEMPERATURE						REMARKS
	HEATING ELEMENT		MODUTHAL® FF		MODUTHAL® 3000 AND 6000		
	°C	°F	°C	°F	°C	°F	
H ₂	1350	2460	1250	2280	1350	2460	H ₂ increases heat conductivity of Moduthal® 3–4 times
N ₂	1200 preoxidized	2190 preoxidized	1250	2280	1350	2460	
N	don't use		–		–		
Endogas	1050 preoxidized	1920 preoxidized	1050	1920	1050	1920	Pay attention to carbon deposition. Gas tight muffle recommended
Exogas	1150 preoxidized	2100 preoxidized	1150	2100	1150	2100	Pay attention to carbon deposition. Gas tight muffle recommended
Sulphur cont. cycle	approx. 1000	approx. 1830	1000	1830	1000	1830	Gas tight muffle recommended
Sulphur interm. cycle	approx. 1000	approx. 1830	see remarks		see remarks		Gas tight muffle recommended
Vacuum <10 ⁻³ hPa	1150 preoxidized	2100 preoxidized	1150	2100	1150	2100	Vacuum tight muffle recommended for vacuum >10 ⁻³ bar
Chlorine, fluorine and alkali	attacks all types of resistant alloys		–		–		
Pressurized	1400	2550	1250	2280	1350	2460	Moduthal® can be used in gas or air-tight furnaces only
Scale	see remarks		see remarks		see remarks		Spray scale from heat-resistant parts is usually satisfactorily tolerated, iron oxide scale attacks Kanthal fit cover
Vapors	see remarks		see remarks		see remarks		Vapors must not form condensates from salts or oxides, otherwise electrical bridges may be formed
Gas velocity	see remarks		see remarks		see remarks		Moduthal® withstands high gas velocities up to 50 m/s (164 ft/s). Pay attention to butt joints with ceramic fiber blankets

MODULE DIMENSIONS



MAXIMUM SIZES FOR MODUTHAL® 3000 AND 6000

	A SIZES		B SIZES		STANDARD C SIZES	
	MM	IN	MM	IN	MM	IN
Roof and walls	max 500 max 350	max 19.7 max 13.8	< 1100 1100–1500	< 43.3 43.3–59.1	50	1.97
Bottom	max 500 max 400	max 19.7 max 15.7	< 1100 1100–1500	< 43.3 43.3–59.1	50	1.97

Dimensional tolerances: A ± 5 mm (0.20 in)
 B ± 5 mm (0.20 in)
 C ± 2 mm (0.08 in)

MAXIMUM SIZES FOR MODUTHAL® FF

	A SIZES		B SIZES		STANDARD C SIZES	
	MM	IN	MM	IN	MM	IN
Roof and walls	max 400 max 350	max 15.7 max 13.8	< 900 900–1100	< 35.4 35.4–43.3	50	1.97
Bottom	max 500 max 400	max 19.7 max 15.7	< 1100 1100–1400	< 43.3 43.3–55.1	50	1.97

Dimensional tolerances: A ± 5 mm (0.20 in)
 B ± 5 mm (0.20 in)
 C ± 2 mm (0.08 in)

Note: Tighter tolerances may be possible, consult Kanthal® if required.

MAXIMUM TEMPERATURE

ACCESSORIES

FLEXIBLE BEAD-INSULATED AND CONNECTING LEADS

The leads for electrical connections consist of Nikrothal® 40 nickel-chromium wire and are multi-twisted. The choice of the proper cross-section depends on the power consumption of Moduthal® panels. The diagrams below can be used to select the correct lead dimension. Remember, however, that the temperature at the terminal connection point must never exceed 200°C (390°F).

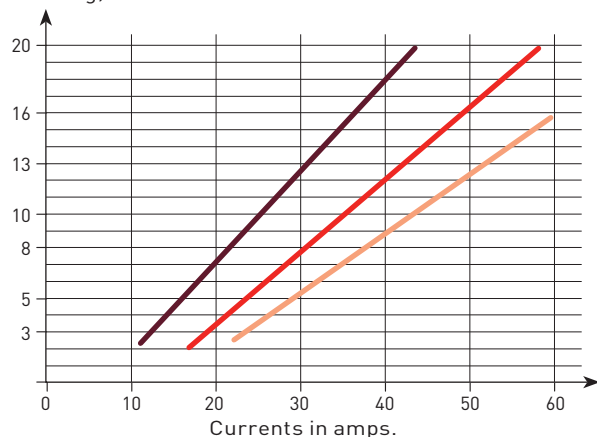
It is also necessary to note that the temperature of the lead in back insulation, in particular the welded connection to the terminal, should not exceed 800°C (1470°F). The lead temperature is due to the combination of inherent heating caused by the passing current (see the diagrams below) and the temperature of the insulation.

OUTER DIMENSIONS, DEPENDING ON NUMBER OF TWISTS

	NUMBER OF TWISTS											
	3 TIMES		5 TIMES		6 TIMES		8 TIMES		10 TIMES		13 TIMES	
	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN
Outside Ø of the twisted lead	3.5	0.14	4.5	0.18	5	0.2	6.5	0.26	7	0.28	8.5	0.33
Outside Ø of the insulating beads	11	0.43	11	0.43	11	0.43	14	0.55	14	0.55	14	0.55

LEADS BEAD-INSULATED IN AIR

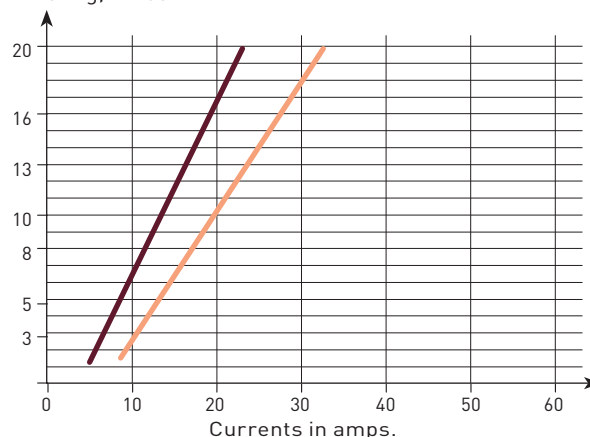
Twisting, times



Lead temperature ■ 100°C (210°F) ■ 150°C (300°F) ■ 200°C (390°F)

LEADS BEAD-INSULATED IN MODUTHAL®

Twisting, times



Lead temperature ■ 100°C (210°F) ■ 200°C (390°F)

TECHNICAL INFORMATION



TECHNICAL DATA FOR MODUTHAL® INSULATION

		MODUTHAL® 3000	MODUTHAL® 6000	MODUTHAL® FF
Main component		fiber	fiber	aluminum silicate
Classification temperature		1600°C (2910°F)	1600°C (2910°F)	1400°C (2550°F)
Maximum working temperature		1500°C (2730°F)	1500°C (2730°F)	1250°C (2280°F)
Melting point		1680°C (3060°F)	1680°C (3060°F)	1400°C (2550°F)
Chemical analysis	Al ₂ O ₃	72-73	70-71	38-40
	SiO ₂	12-13	13-15	27-29
	CaO	10-11	10-11	33-35
Density after firing at 1000°C, kg/m ³ (at 1830°F, lb/ft ³)		1100-1200 (68.7-74.9)	1000 (62.4)	1200 (74.9)
Thermal conductivity, W/mK (W/inF)	110°C (230°F)	-	-	167 (2.36)
	800°C (1470°F)	80 (1.13)	63 (0.89)	146 (2.06)
	1000°C (1830°F)	-	-	201 (2.84)
	1200°C (2190°F)	117 (1.65)	92 (1.30)	-
	1350°C (2460°F)	163 (2.30)	125 (1.76)	-
Thermal expansion, %	1000°C (1830°F)	0.65	0.60	0.65
	1500°C (2730°F)	1.40	-1.30	-
Shrinkage, %	110°C (230°F)	none	none	0.10
	1000°C (1830°F)	0.10	none	none
	1500°C (2730°F)	0.15	1.30	-
Compr. strength, MPa (lb/in ²)	after firing	15.7 (2276)	15.2 (2204)	13.7 (1991)
	700°C (1290°F)	6.4 (924)	5.9 (853)	7.8 (1138)
	1000°C (1830°F)	6.6 (953)	6.0 (868)	8.3 (1209)
	1500°C (2730°F)	8.4 (1223)	7.3 (1053)	-
	Drying and firing	firing at 50°C/h (120°F/h) one stop of 5h at 150°C (300°F)		

