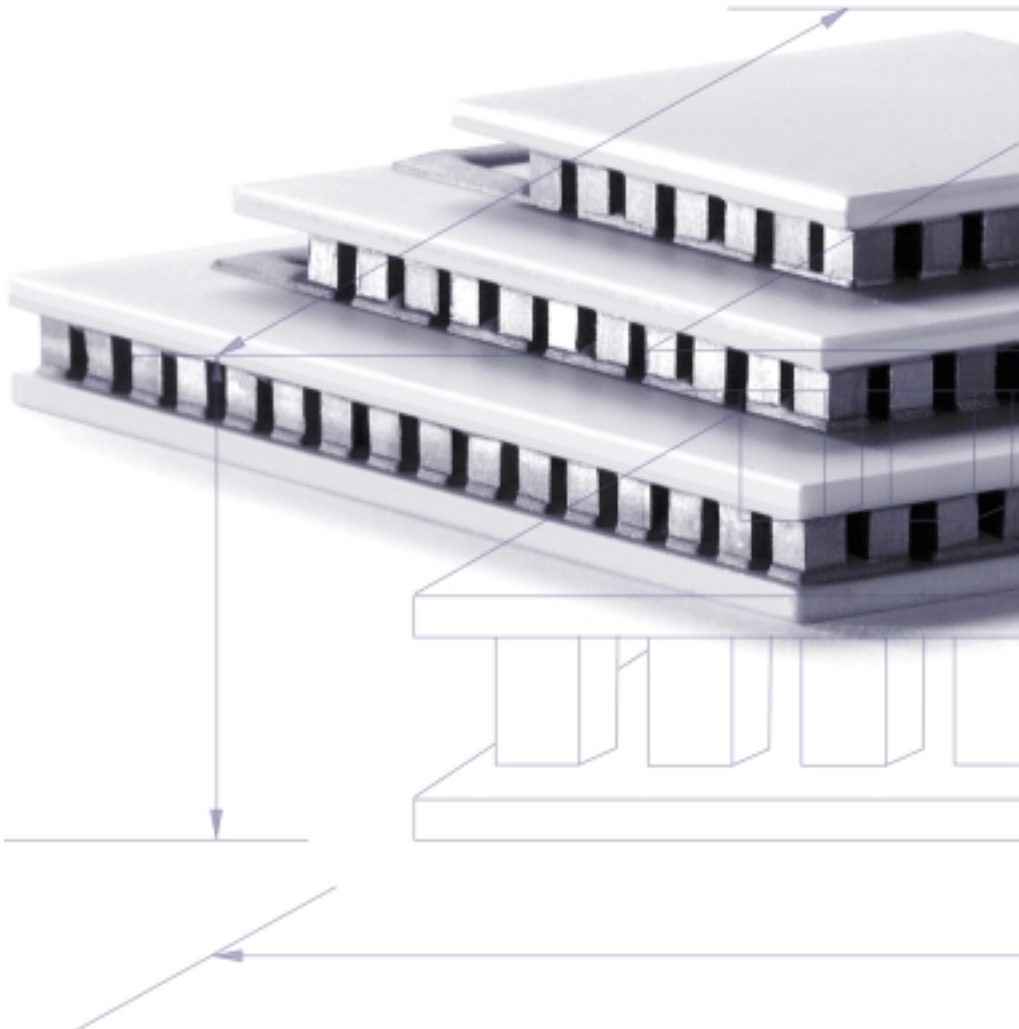
FerroTec

Thermoelectric Modules



Thermoelectric Modules

Dear Customer,

Thank you for interest in Ferrotec thermoelectric modules.

Ferrotec, a manufacturer of thermoelectric raw materials and modules, was founded in the late 1980's and has continuously developed high quality products at competitive prices to serve the needs of today's businesses worldwide.

Ferrotec is recognised as one of the most reliable providers in a wide variety of market segments, with applications ranging from consumer products to precise temperature control systems. Our flexibility and expertise enables us to offer our products with short delivery times through direct sales channels.

Working closely with our customers as partners, Ferrotec also specialises in the development and manufacture of custom modules. We are committed to providing strong technical support and service throughout the design process and beyond.

With ISO 9001:2000 and ISO 14001 accreditations, you can be assured of quality each and every time you use a Ferrotec product.

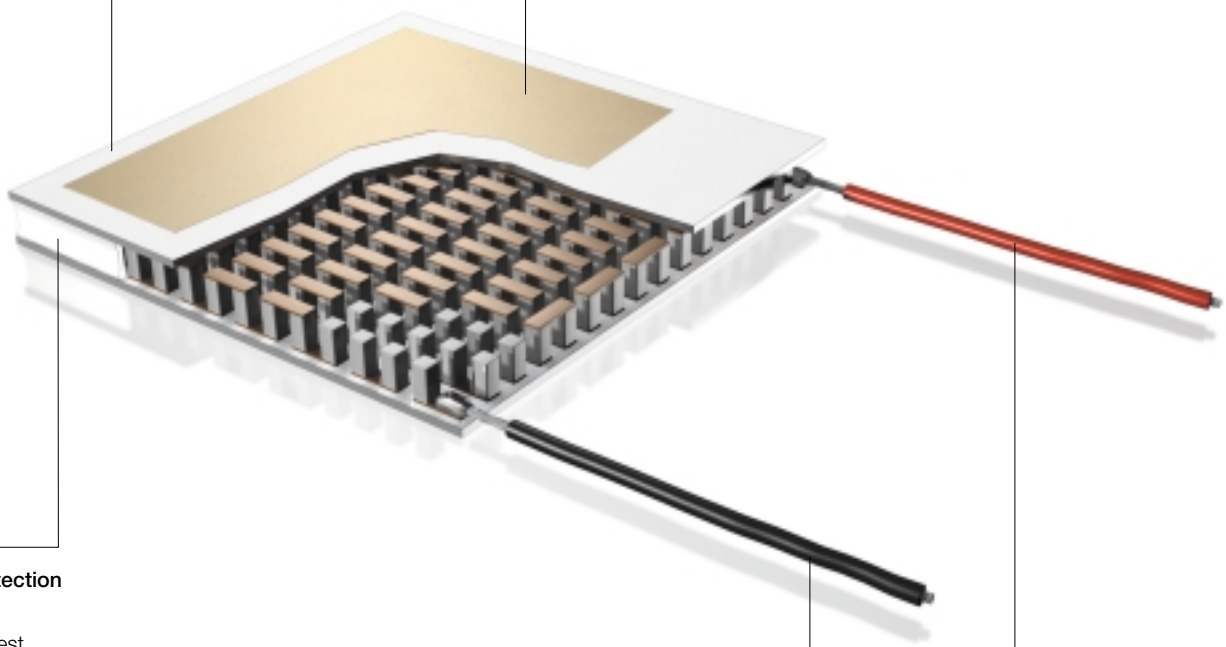
Substrate Surface
pre-tinned/metallized
hot and/or cold side

Solder	Melting point
In/Sn	118° C
Bi/Sn	138° C
Sn/Sb	183° C

Cu/Ni/Au
Specific to your needs

Substrate Material

Ceramic
Aluminium Nitride



Moisture Protection

RTV-seal
Other on request

Wires
Standard:
Teflon 133 mm Length

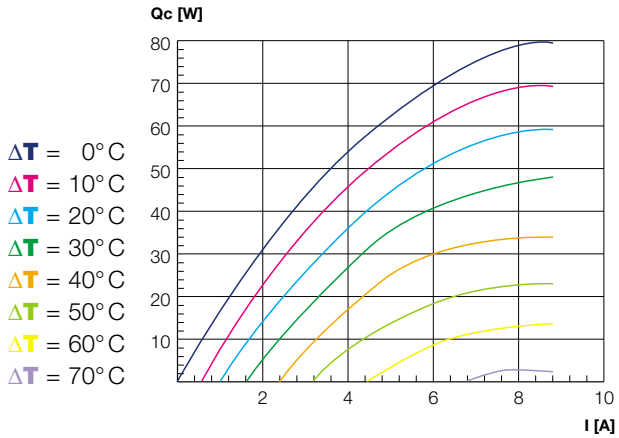
Options: PVC, Bare
Length: Customized

Technical Introduction

A thermoelectric (TE) cooler, sometimes called a thermoelectric module, is a semiconductor based electronic component that functions as a small heat pump. By applying a low voltage DC power source to a TE module, heat will be moved through the module from one side to the other. One module face, therefore, will be cooled while the opposite face simultaneously is heated. It is important to note that this phenomenon is fully reversible whereby a change in the polarity (plus and minus) of the applied DC voltage will cause heat to be moved in the opposite direction. Consequently, a thermoelectric module may be used for both cooling and heating.
A thermoelectric cooler generally consists of two or more semiconductor elements, usually made of bismuth telluride (Bi2Te3), that are connected electrically in series and thermally in parallel. These thermoelectric elements and their interconnects typically are mounted between two thin metallized ceramic substrates, which provide structural integrity, insulate the elements electrically from external mounting surfaces, and provide flat contact surfaces.

Both n-type and p-type Bi2Te3 materials are used in a thermoelectric cooler. This arrangement causes heat to move trough the cooler in one direction only while the electrical current moves back and forth alternately between the top and bottom substrates trough each n- and p-type element. The n-type material is doped so that it will have an excess of electrons while the p-type material is doped so that it will have a deficiency of electrons. The extra electrons in the n material and the „holes“ resulting from the deficiency of electrons in the p material are know as carriers. These carriers move the heat energy through the thermoelectric material.

Heat flux – the heat actively pumped trough the thermoelectric module – is proportional to the magnitude of the applied DC electric current. By varying the input current from zero to maximum, one can adjust and control the heat flow and temperature differential.



Qc vs. I
This graph shows the module's heat pumping capacity (Qc) in watts as a function of input current (I) at various differential temperatures across the module (DT). This data allows the user to determine whether the module under consideration has sufficient heat removal capacity to meet the application requirements.

Ferrotec's thermoelectric modules generally have between seven and 128 couples with maximum operating current ratings from 1,2 to 36 A, although larger and smaller modules are available. Modules can be mounted in parallel to increase the heat transfer capacity, or they can be stacked in multistage cascades to increase the temperature differential.

Thermoelectric modules have no moving parts, so they are virtually maintenance free. They are also smaller and lighter than comparable mechanical cooling systems. However thermoelectric modules are not ideal for every cooling application, and there are situations in which a simpler cooling device, such as a heat sink, is more appropriate. They also would not cool to as low a temperature as mechanical coolers. There are also situations, in which thermoelectric cooling is the only suitable solution or for which it presents significant advantages over than other cooling methods. Thermoelectric coolers can provide active cooling, which means below ambient temperature. Their solid-state construction ensures high reliability, which is an advantage when they are to be used in a system that is not easily accessible after installation. Operation is acoustically silent and electrical interference is negligible.

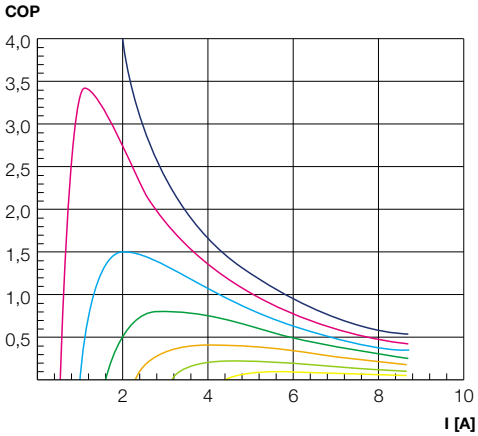
Selection of the proper TE cooler for a specific application requires an evaluation of the total system in which the cooler will be used. For most applications it should be possible to use one of standard module configurations while in certain cases a special design may be needed to meet stringent electrical, mechanical, or other requirements. Although we encourage the use of a standard module whenever possible, Ferrotec specialises in the development and manufacture of custom TE modules and we will be pleased to provide technical solution on unique modules that will exactly meet your requirements.

The overall cooling system is dynamic in nature and system performance is a function of several interrelated parameters*.
If there is any uncertainly about which TE module would be most suitable for a particular application, we highly recommend that you contact our sales team or our local representative for assistance.

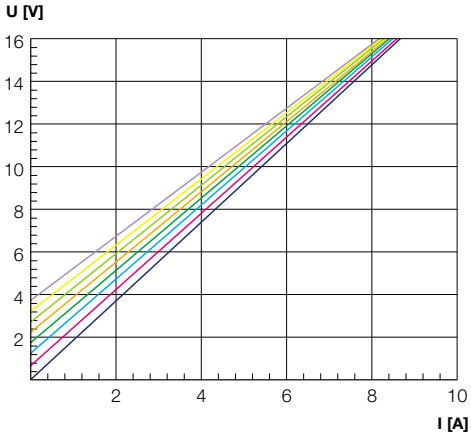
Before starting the actual TE module selection process, the designer should be able to answer the following questions:

- At what temperature must the cooled object be maintained, and to what precision?
- How much heat must be removed from the cooled object?
- What is the expected ambient temperature range? Will the temperature change significantly during operation?
- What is the thermal resistance of the heat sink (hot side) and what is the interface material be used?
- What is the allowable footprint and height for the module?
- What DC power is available?
  What voltage and current restrictions exist?
- What is the expected temperature of the heat sink during operation?
  Is this temperature steady or variable?
- How will the modules be mounted?

Each application will have its own set of performance that will vary in the temperature of the module hot side (Th). Performance data is presented graphically and there are three important key graphs explaining the module performance.



COP
This important graph relates the coefficient of performance (COP) and DT to input current. The COP is equal to the heat pumped divided by the input power. This graph enables the user to determine the coefficient of performance (efficiency) to maximise the cooling capacity and minimise the heat rejected to the heat sink.



U vs. I
A graph of U vs. I depicts the voltage necessary to produce the current needed at various differential temperatures. If you have selected an appropriate module, established the correct operating current from the Qc vs. I graph, and figured out the DT value, you can use this chart to determine the power supply requirements.

* For more technical details please request our TE catalogue.

Single Stage Modules

The single stage TE series is suitable for a wide range of various cooling and heating applications which requires medium or high pumping capacity. Typical application areas include biomedical instruments, consumer products, industrial, electrial equipment and laboratory and scientific instruments. Standard substrates are lapped with ± 25 µm tolerance. These modules are also available with different configurations. For more information please refer to page „Features and Options at a Glance“.

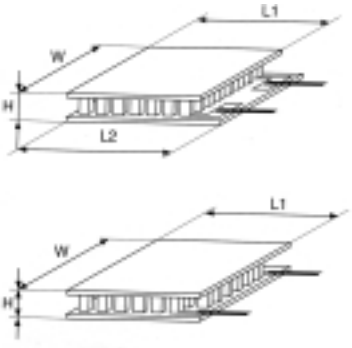
	TE Module No. 200° C	Imax (A)	Qmax (W)	Vmax (V)	DTmax (°C)	T	Dimensions (mm) W	L	H
1,2 A Modules	9500/007/012	1,2	0,6	0,9	70	1	4,01	4,01	2,33
	9500/018/012	1,2	1,6	2,5	70	2	6,05	6,05	2,59
	9502/031/012	1,2	2,8	4,3	70	1	7,98	7,98	2,08
	9502/065/012	1,2	5,8	8,9	70	1	12,10	11,20	2,59
1,8 A Modules	9500/007/018	1,8	0,9	0,9	70	1	4,01	4,01	2,03
	9500/018/018	1,8	2,4	2,5	70	2	6,05	6,05	2,28
	9502/023/018	1,8	3,1	3,2	70	1	6,05	7,98	1,77
	9502/029/018	1,8	3,9	4,0	70	1	6,05	9,91	1,77
	9502/031/018	1,8	4,1	4,3	70	1	7,98	7,98	1,77
	9502/065/018	1,8	8,7	8,9	70	1	12,10	11,20	2,28
3,0 A Modules	9501/017/030	3,0	3,8	2,3	72	1	11,50	11,50	3,18
	9501/023/030	3,0	5,2	3,2	72	1	7,39	22,40	3,18
	9501/031/030	3,0	7,0	4,3	72	1	15,10	15,10	3,18
	9501/071/030	3,0	16,0	9,8	72	1	22,40	22,40	3,18
	9501/127/030	3,0	29,0	17,5	72	1	29,70	29,70	3,94
4,0 A Modules	9500/017/040	4,0	5,1	2,3	72	1	15,01	15,10	4,16
	9501/017/040	4,0	5,1	2,3	72	1	11,50	11,50	3,18
	9501/023/040	4,0	6,9	3,2	72	1	7,39	22,40	3,18
	9500/031/040	4,0	9,3	4,3	72	1	20,00	20,00	4,16
	9501/031/040	4,0	9,3	4,3	72	1	15,10	15,10	3,18
	9500/035/040	4,0	10,0	4,8	72	1	15,10	29,80	4,16
	9500/071/040	4,0	21,0	9,8	72	1	29,80	29,80	4,16
	9501/071/040	4,0	21,0	9,8	72	1	22,40	22,40	3,18
	9500/127/040	4,0	38,0	17,5	72	1	39,70	39,70	4,16
	9501/127/040	4,0	38,0	17,5	72	1	29,70	29,70	3,94

The following symbols are used in the tables:

Imax Maximum input current in amperes
Qmax Maximum heat pumping capacity in watts at DT = 0
Vmax Maximum DC input voltage in volts at Imax and DT = 30° C
DTmax Maximum temperature differential in °C at a zero heat load (Q = 0)
T Type of modul

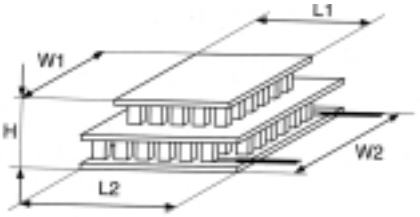
TE Module No. 200° C	Imax (A)	Qmax (W)	Vmax (V)	DTmax (°C)	T	Dimensions (mm) W	L	H	
9500/017/060	6,0	7,6	2,3	72	1	15,10	15,10	4,16	**6,0 A Modules**
9500/031/060	6,0	14,0	4,3	72	1	20,00	20,00	4,16	
9500/035/060	6,0	16,0	4,8	72	1	15,10	29,80	4,16	
9500/071/060	6,0	32,0	9,8	72	1	29,80	29,80	4,16	
9500/127/060	6,0	57,0	17,5	72	1	39,70	39,70	4,16	
9501/127/060	6,0	57,0	17,5	72	1	29,70	29,70	3,61	
9500/128/060	6,0	57,0	17,6	72	2	39,70	39,70	4,16	
9500/017/085	8,5	11,0	2,3	72	1	15,10	15,10	3,94	**8,5 A Modules**
9500/031/085	8,5	20,0	4,3	72	1	20,00	20,00	3,94	
9500/035/085	8,5	22,0	4,8	72	1	15,10	29,80	3,94	
9500/071/085	8,5	45,0	9,8	72	1	29,80	29,80	3,94	
9500/127/085	8,5	80,0	17,5	72	1	39,70	39,70	3,94	
9500/128/085	8,5	80,0	17,6	72	2	39,70	39,70	3,94	
9500/031/090	9,0	22,0	4,3	72	1	29,80	29,80	4,65	**9,0 A Module**
9500/127/100	10,0	95,0	17,5	72	1	39,70	39,70	3,64	**10,0 A Module**
9504/071/120	12,0	63,0	9,8	72	1	40,10	40,10	4,65	**12,0 A Modules**
9500/127/120	12,0	114,0	17,5	72	1	39,70	39,70	3,45	
9500/031/150	15,0	35,0	4,3	72	1	29,80	29,80	4,60	**15,0 A Modules**
9500/071/150	15,0	79,0	9,8	72	1	40,10	40,10	4,65	
9505/127/150	15,0	142,0	17,5	72	1	40,00	40,00	3,45	
9504/031/240	24,0	55,0	4,3	72	1	39,70	39,70	4,62	**24,0 A Module**

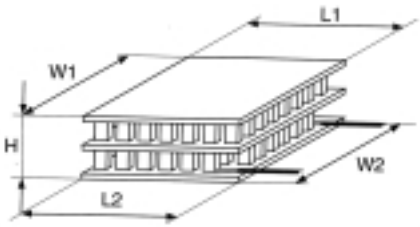
Type 2 thermoelectric modules feature a „porch“ for easy attachment of leads. This makes the L2 dimensions slightly longer than the L1 dimension. Please call for exact L2 measurements for the modules that you are interested in.



Multistage Modules

The multistage TE series is suitable for low temperature applications where a small or medium cooling capacity is required. Typical application areas include IR-detectors, CCD arrays and electro-optic. These modules are also available with different configurations and cascade designing to provide higher temperature differentials than are obtainable with standard single modules. For more information please refer to page „Features and Options at a Glance“ or contact Ferrotec with your specific design requirements.





2 Stage Modules

TE Module No. 200° C	Imax (A)	Qmax (W)	Vmax (V)	DTmax (°C)	T	Dimensions (mm) W1	L1	W2	L2	H
9520/157/035	3,5	11,0	18,2	106	1	20,0	20,0	39,6	39,6	7,39
9520/185/065	6,5	37,0	17,9	95	1	29,8	29,8	39,7	39,7	6,99
9520/157/070	7,0	24,0	17,3	106	1	20,0	20,0	39,7	39,7	6,99
9520/094/360	24,0	74,0	8,2	88	2	45,2	5,1	45,2	45,1	7,49

3 Stage Modules

TE Module No. 200° C	Imax (A)	Qmax (W)	Vmax (V)	DTmax (°C)	T	Dimensions (mm) W1	L1	W2	L2	W3	L3	H
9530/119/045 M	4,5	9,7	8,6	111	1	15,2	15,2	20,0	20,0	29,8	29,8	9,20
9530/228/045 M	4,5	18,0	16,4	111	1	20,0	20,0	29,8	29,8	39,7	39,7	9,82

Miniature Modules

The miniature TE series is suitable for various cooling and heating applications where a small amount of heat is involved. Typical application areas include laser diode cooling, infrared systems, electro-optic, telecommunication and electronic equipment. These modules are also available with different configurations. For more information please refer to page „Features and Options at a Glance“.

TE Module Number 200° C	Imax (A)	Qcmax (W)	Vmax (V)	DTmax (°C)	T	Dimensions (mm) W	L	H
9503/018/012 M	1,2	1,6	2,5	70	1	6,05	7,19	1,64
9503/018/018 M	1,8	2,4	2,5	70	1	6,05	7,19	1,64
9503/023/018 M	1,8	3,1	3,2	70	1	6,05	8,18	1,64
9503/029/018 M	1,8	3,9	4,0	70	1	6,05	10,20	1,64
9503/031/018 M	1,8	4,1	4,3	70	1	7,98	7,98	1,64
9503/035/018 M	1,8	4,7	4,8	70	1	6,05	12,20	1,64
9503/018/020 M	2,0	2,6	2,5	70	1	6,05	7,19	1,64
9503/035/025 M	2,5	6,5	4,8	70	1	6,05	12,20	1,64

Long-Life Modules 70 Series

Ferrotec's 7000 series has been specifically designed for cycling applications. Tests show module lifetimes many times greater than a standard module under the same thermal cycling conditions. The obtained change in AC resistance is significant smaller than 5 %. Typical application areas include instrumentation, chillers, PCR Cyclers and analysers. These modules are also available with different configurations. For more information please refer to page „Features and Options at a Glance".

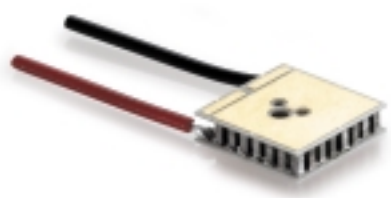
TE Module Number	Imax	Qcmax	Vmax	DTmax	T	Dimensions (mm)		
200° C	(A)	(W)	(V)	(°C)		W	L	H
7000/127/060 B	6,0	51	17,5	72	1	39,70	39,70	4,16
7000/127/085 B	8,5	72	17,5	72	1	39,70	39,70	3,94
7000/131/150 B	15,0	31	4,3	72	1	29,80	29,80	4,60
7004/071/150 B	15,0	71	9,8	72	1	40,10	40,10	4,65
7004/031/240 B	24,0	49	4,3	72	1	39,70	39,70	4,62

Center Hole Modules

The Center Holes TE series is suitable for a wide range of various cooling and heating applications which requires medium pumping capacity. Typical application areas include industrial, electrical equipment and laboratory and opto-electronics. Standard substrates are lapped with ± 25 µm tolerance. These modules are also available with different configurations. For more information please refer to page „Features and Options at a Glance".

TE Module Number	Imax	Qmax	Vmax	DTmax	T	Dimensions (mm)			
200° C	(A)	(W)	(V)	(°C)		W	L	H	Hole Dia.
9506/023/030 B	3,0	5,2	3,2	72	1	15,10	15,10	3,18	6,70
9506/023/040 B	4,0	6,9	3,2	72	1	15,10	15,10	3,18	5,00
9504/023/040 B	4,0	6,9	3,2	72	1	18,00	18,00	3,18	8,00

Multi Hole Modules



The multi hole TE series has been specifically designed for CAN type laser diodes. The increased contact area between the TE module and laser diode package enables a more uniform cooling and the target temperature is achieved more rapidly. The optimised thermal contact area results in a very stable thermal performance to the laser diode. The standard series is available for laser diodes with diameters ranging from 3,5 - 9,0 mm. **For other specific laser diode sizes or design requirements please contact Ferrotec.**

Power Generator

The cooling or heating effect of a TE module is caused by the Peltier effect. By applying a heat to the module's surface, the Seebeck effect is responsible for converting this heat into electrical power and the TE module then works as a generator. The Seebeck voltage of a TE module is determined by the applied temperature difference on the BiTe elements and also by the overall numbers of elements (dice) used in its construction.

The thermal conductivity (W/K) of the module is the most important characteristic and it is given through the geometry of each single element used in a module. All elements within a complete module are designed with a fixed geometry.

This geometry coefficient, which is the ratio of the element's surface to its length (A/L in cm), determines the maximum current capability of the element and is therefore „the value" for the generated power. The maximum DC voltage generated is obtained without any load resistance, i.e. in open circuit. But in operating mode with an adapted load resistance, the obtained output voltage drops by approximately 50 %. For most applications, the required voltage can be achieved by using several modules, arranged and teamed in parallel / series configurations.

Besides the thermoelectric module itself, an efficient design takes into consideration the heat sink, heat source and interface material as well. It is often overlooked that only a limited part of the applied heat is transformed into electrical power; the greater part of the heat therefore has to be released on the heat sink side.

For more information or help with your design, please contact us.

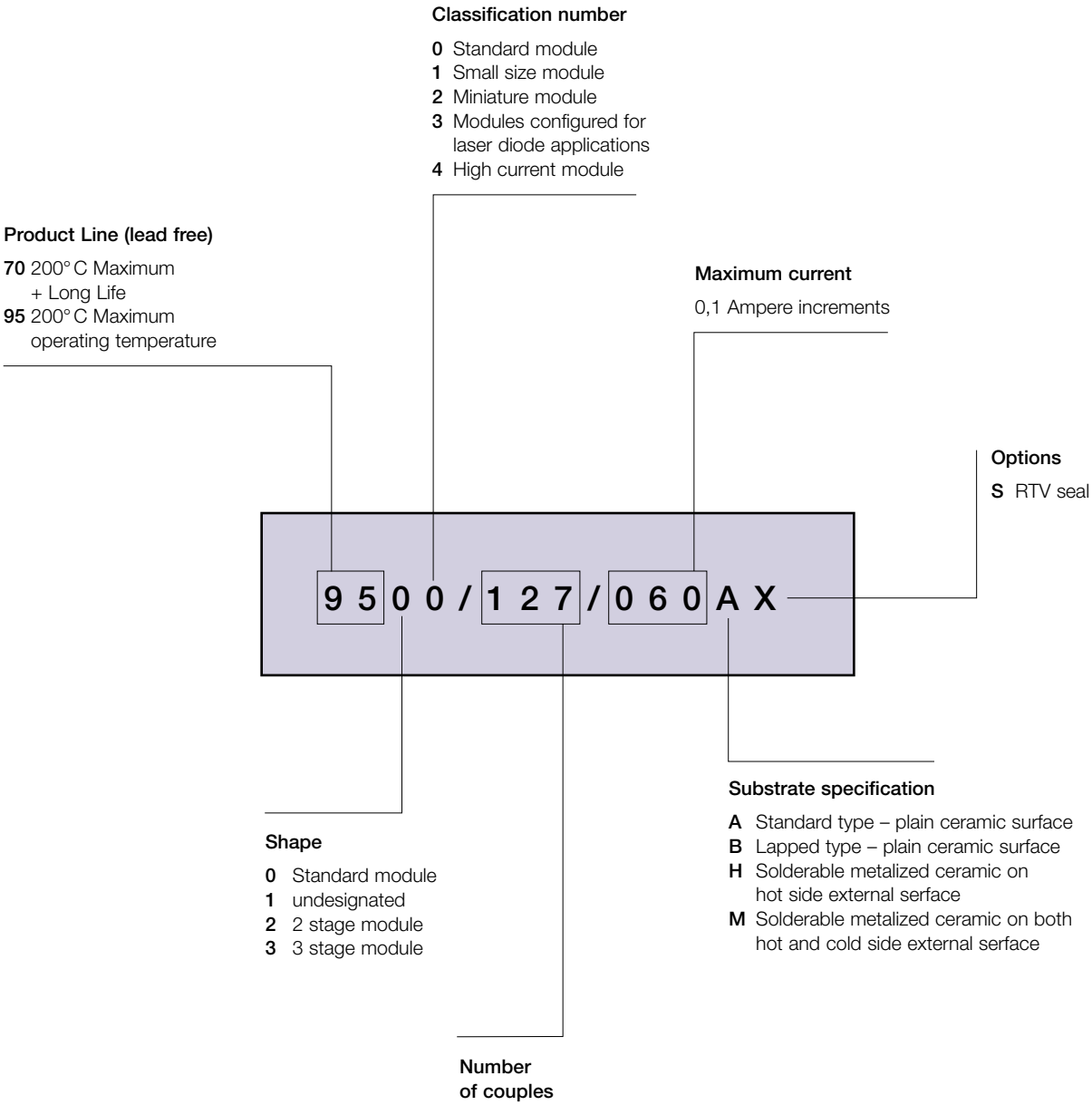
Service 24-hours delivery time

Avoid any bottleneck in you production.
24-hours delivery service within Europe.
Please contact Ferrotec for further information and possibilities about this service.
DS – 024 – x

Training

$$\Delta T = T_H - T_C$$

How to approach to a proper TE solution according to your needs?
For groups from 2- max 12 persons.
Duration 1 day. Please contact Ferrotec for further details.
TT001 – x


Classification number
0 Standard module
1 Small size module
2 Miniature module
3 Modules configured for laser diode applications
4 High current module
Product Line (lead free)
70 200° C Maximum + Long Life
95 200° C Maximum operating temperature
Maximum current
0,1 Ampere increments
Options
S RTV seal
9 5 0 0 / 1 2 7 / 0 6 0 A X
Shape
0 Standard module
1 undesignated
2 2 stage module
3 3 stage module
Number of couples
Substrate specification
A Standard type – plain ceramic surface
B Lapped type – plain ceramic surface
H Solderable metalized ceramic on hot side external serface
M Solderable metalized ceramic on both hot and cold side external serface