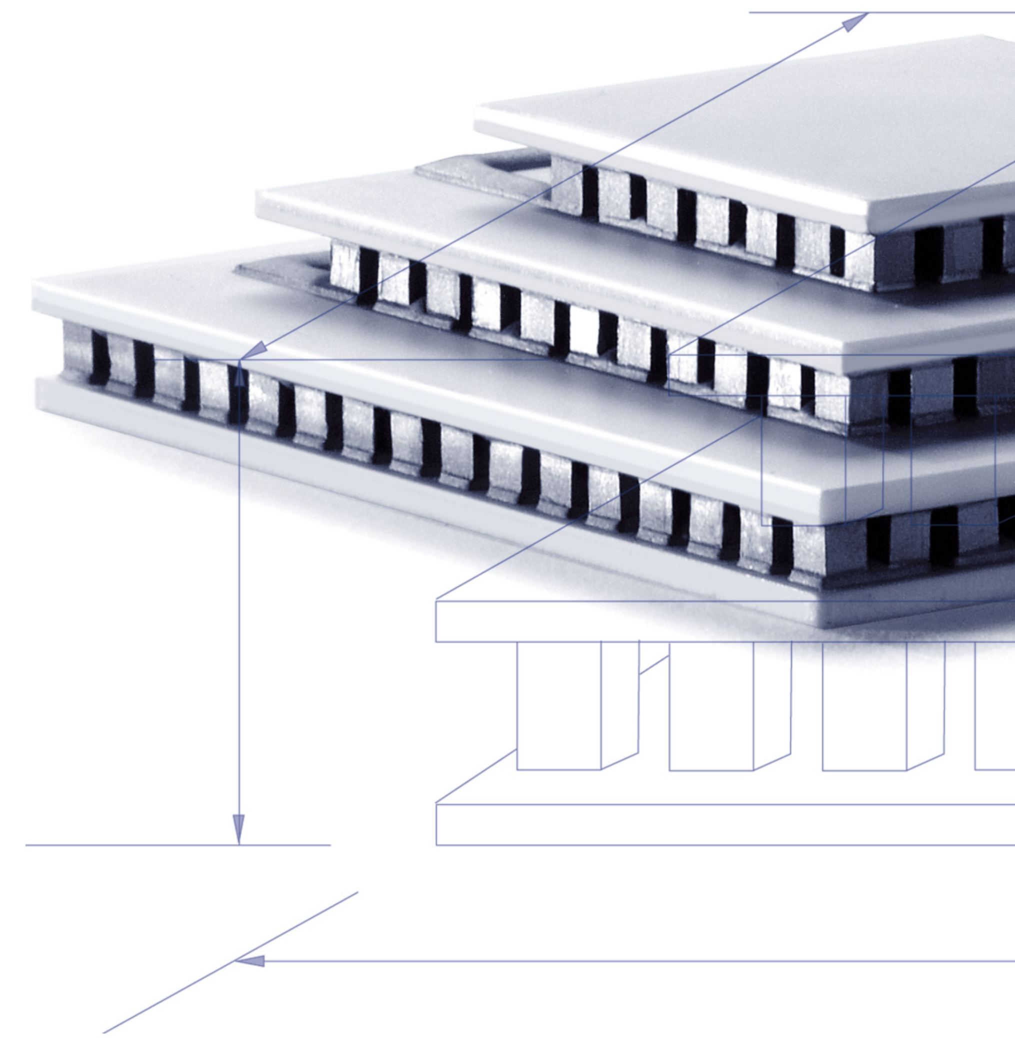
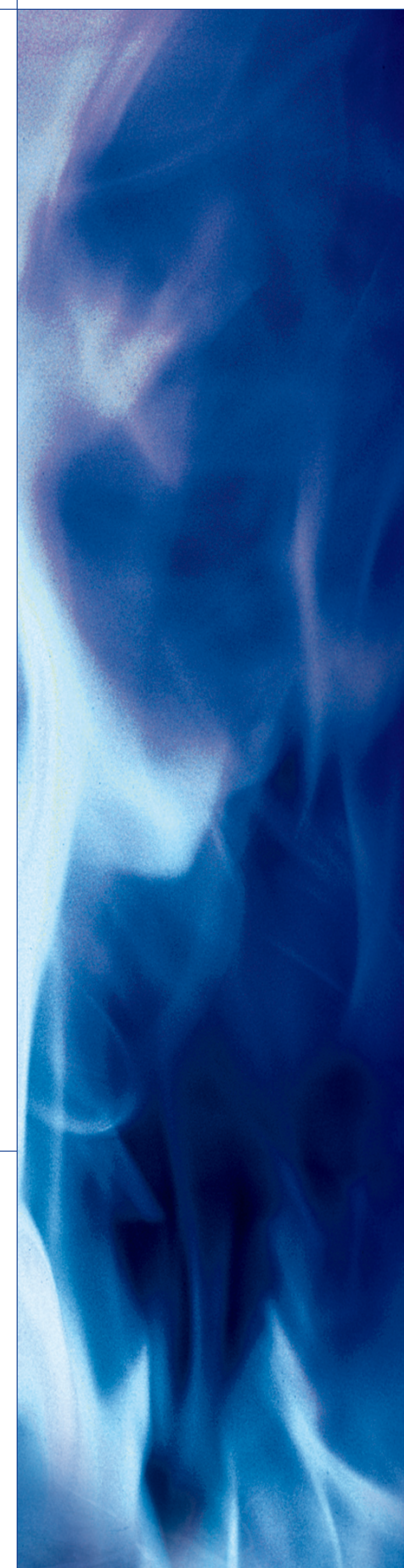
Thermoelectric Modules





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Features and Options at a Glance

Thermoelectric Module (TEM)

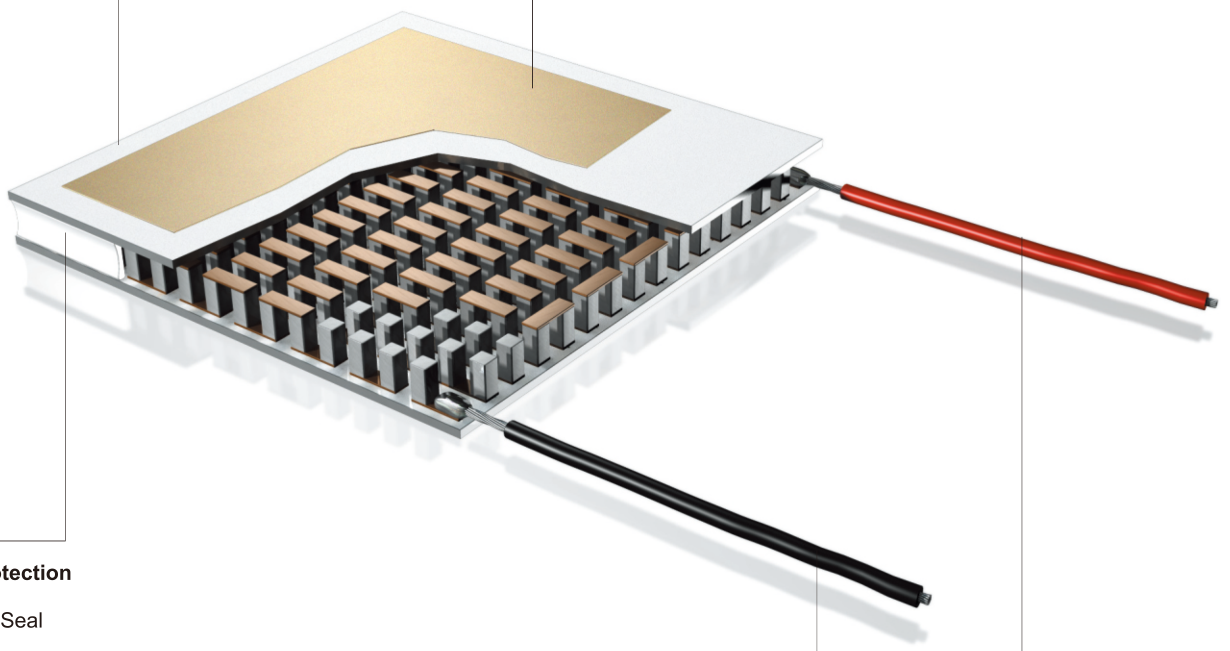
Dear Customer,

Thank you for your interest in Ferrotec thermoelectric products. Ferrotec, a manufacturer of thermoelectric modules and assemblies, 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 recognized 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 enable us to offer effective product solutions with short delivery times through our global sales channels.

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

With ISO 9001, ISO 14001 and ISO/TS 16949 accreditations, you can be assured of high quality with all Ferrotec products.



All TEMs are RoHS compliant

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Technical Introduction

A thermoelectric module (TEM), also called a thermoelectric cooler (TEC) or device, is a semiconductor based electronic component that functions as a compact and efficient heat pump. By applying a low voltage DC power source to a TEM, 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 of the applied DC voltage will cause heat to be moved in the opposite direction. Consequently, a TEM may be used for both cooling and heating in a given application. A TEM generally consists of two or more semiconductor elements, usually made of bismuth telluride (Bi_2Te_3), that are connected electrically in series and thermally in parallel. These thermoelectric elements and their interconnects typically are mounted between two thin metalized ceramic substrates, which provide structural integrity, insulate the elements electrically from external mounting surfaces. and provide flat and parallel contact surfaces.

Both n-type and p-type Bi_2Te_3 materials are used in a TEM. This arrangement causes heat to move through the cooler in one direction only while the electrical current moves back and forth alternately between the top and bottom substrates through each n-type and p-type element. The n-type material is doped to have an excess of electrons while the p-type material is doped to 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 serve as carriers. These carriers move the heat energy through the thermoelectric material.

Heat flux (the heat actively pumped through the TEM) is proportional to the magnitude of the applied DC electric current. By regulating the input current from zero to maximum, one can adjust and precisely control the heat flow and module temperature differential.

TEMs can be mounted in parallel to increase the heat transfer capacity, or they can be stacked in multistage cascades to increase the temperature differential.

TEMs have no moving parts, so they are reliable and virtually maintenance free. They are also smaller, lighter and quieter than comparable mechanical cooling systems. However, TEMs are not ideal for every cooling application, and there are situations in which a simple passive cooling device, such as a heat sink, is more appropriate. There are also situations in which thermoelectric cooling is the only suitable solution, or for which it presents significant advantages over other cooling methods. TEMs can provide active cooling, which means they cool below ambient temperature, which is not possible with heat sinks alone. 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 TEM for a specific application requires an evaluation of the total system in which the TEM will be used. For most applications it should be possible to use a standard TEM configuration, while in certain cases a special design may be needed to meet stringent heat pumping, electrical, mechanical, or other design requirements. Although we encourage the use of a standard TEM whenever possible, Ferrotec specializes in the development and manufacture of custom TEMs. We will be pleased to provide technical analysis to define a unique TEM design that meets your requirements precisely.

Most cooling systems are dynamic in nature, and overall system performance is a function of several interrelated parameters. If there is any uncertainty about which TEM would be most suitable for a particular application, we recommend that you contact our sales team or your local representative for assistance.

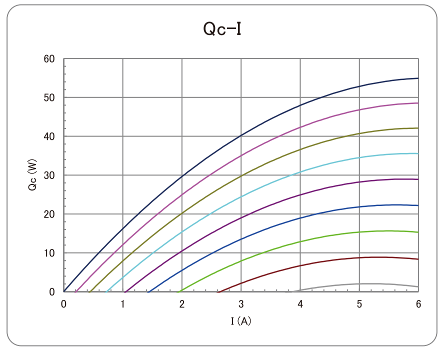
Before starting the actual TEM selection process, the designer should be able to answer the following questions:

- 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 to be used?
- What is the allowable footprint and height of 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 TEMs be mounted?

Each application will have its own set of parameters that will impact the temperature of the TEM hot side (Th). Performance data is presented graphically and there are four important attribute graphs explaining the TEM performance.

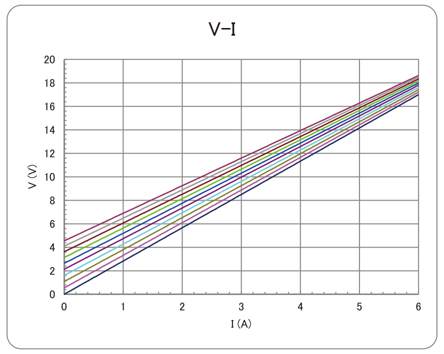
See the four graphs at the bottom of page 2 and 3.

ΔT = 0°C
ΔT = 10°C
ΔT = 20°C
ΔT = 30°C
ΔT = 40°C
ΔT = 50°C
ΔT = 60°C
ΔT = 70°C
ΔT = 80°C
ΔT = 90°C



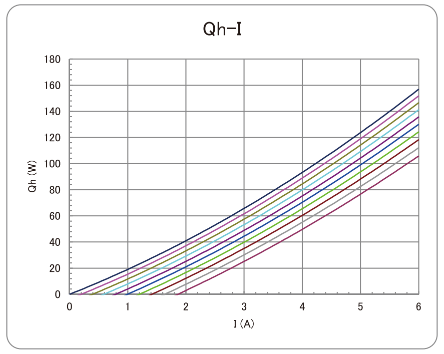
Qc vs. I

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



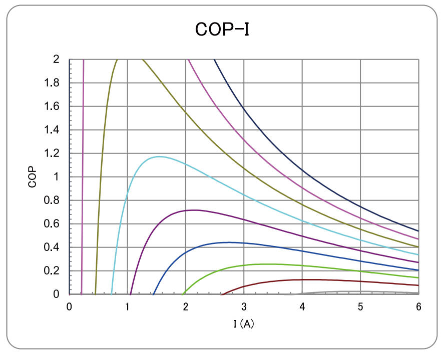
V vs. I

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



Qh vs. I

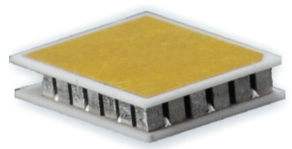
The graph Qh vs. I shows the expelled heat (Qh) in watts, from the hot side of the TEM as a function of current level at a specific Th level. The quantity Qh is the sum of Qc (cooling capacity) and I x V (electrical power in).

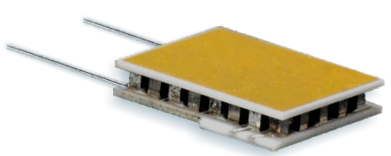


COP vs. I

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

Miniature Modules



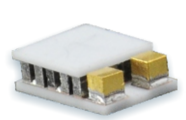


The Miniature Module series is developed for rigorous high ambient temperature and components miniaturization.The TECs use high performance semiconductor material and special assembly technology. These modules are typically used in optical communication industry such as laser transmitter, optical receiver, pump laser etc. These TECs are also available with different configurations.

(Th=50°C)

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W	L1	L2	H
20003/007/012M	1.2	1.0	80	0.7	4.0	4.0	—	2.20
20023/017/012M	1.2	2.5	80	1.6	6.1	6.1	—	1.95
20033/018/012M	1.2	2.7	80	1.7	6.1	6.1	7.19	1.95
20003/018/012M	1.2	2.7	80	1.7	6.1	6.1	7.62	1.95
20023/023/012M	1.2	3.4	80	2.2	8.2	6.1	—	1.95
20023/029/012M	1.2	4.3	80	2.8	10.2	6.1	—	1.95
20023/031/012M	1.2	4.6	80	3.0	7.98	7.98	—	1.95
20023/065/012M	1.2	9.6	80	6.3	12.1	11.2	—	1.95
20001/007/018M	1.8	1.0	80	1.0	4.0	4.0	—	1.90
20021/017/018M	1.8	2.5	80	2.5	6.1	6.1	—	1.65
20031/018/018M	1.8	2.7	80	2.6	6.10	6.1	7.19	1.65
20001/018/018M	1.8	2.7	80	2.6	6.1	6.1	7.62	1.65
20031/023/018M	1.8	3.4	80	3.3	6.1	8.2	—	1.65
20021/029/018M	1.8	4.3	80	4.2	6.1	10.2	—	1.65
20021/031/018M	1.8	4.6	80	4.5	7.98	7.98	—	1.65
20031/035/018M	1.8	5.2	80	5.1	6.1	12.2	—	1.65
20021/065/018M	1.8	9.6	80	9.4	12.1	11.2	—	1.65
20031/018/020M	2.0	2.7	80	2.9	6.10	6.1	7.19	1.65
20031/023/020M	2.0	3.4	80	3.7	6.1	8.2	—	1.65
20021/029/020M	2.0	4.3	80	4.7	6.1	10.2	—	1.65
20001/031/020M	2.0	4.6	80	5.0	8.0	8.0	—	1.65
20031/035/020M	2.0	5.2	80	5.6	6.1	12.2	—	1.65
20038/023/022M	2.2	3.4	80	4.1	6.1	8.2	—	1.45
20038/023/024M	2.4	3.4	80	4.4	6.1	8.2	—	1.45
20038/035/025M	2.5	5.2	80	7.0	6.1	12.2	—	1.45

Micro Modules



The Micro Module series is especially developed for the demands of telecom applications. These TECs are also available with different configurations.

(Th=50°C)

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W	L1	L2	H
20016/008/010M	1.0	1.1	76	0.6	2.3	2.3	3.3	1.13
20036/012/010M	1.0	1.7	76	0.9	3.4	2.3	3.3	1.13
200B6/018/010M	1.0	2.5	76	1.4	3.4	3.4	4.4	1.13
20036/024/010M	1.0	3.3	76	1.8	3.4	4.5	5.5	1.13
20015/008/015A	1.5	1.1	76	0.9	2.3	2.3	3.3	0.98
20035/012/015A	1.5	1.7	76	1.4	3.4	2.3	3.3	0.98
200B5/018/015A	1.5	2.5	76	2.0	3.4	3.4	4.4	0.98
20035/024/015A	1.5	3.3	76	2.7	3.4	4.5	5.5	0.98

All TEMs are RoHS compliant

Single Stage Modules

The Single Stage Module series is suitable for a wide range of applications which require medium or high pumping capacity combined with excellent efficiency, especially where temperature needs precisely stabilized. Typically applications include optical, industrial and laboratory equipment. Standard substrates are lapped with ±0.025 mm tolerance. On request, these TEMs are available with different configurations, other dimensions and electrical specifications.

(Th=50°C)

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W	L1	L2	H
20013/017/030B	3.0	2.4	83	3.8	11.5	11.5		2.90
20013/023/030B	3.0	3.3	83	5.1	7.4	22.4		2.90
20005/017/040B	4.0	2.4	83	5.1	15.1	15.1		3.10
20013/031/040B	4.0	4.4	83	9.2	15.1	15.1		2.90
20005/035/040B	4.0	5.0	83	10	15.1	29.8		3.95
20015/063/040B	4.0	9.0	83	19	39.7	20.1		3.95
20013/071/040B	4.0	10.1	83	21	22.4	22.4		2.90
20003/031/085B	8.5	4.4	83	20	20.0	20.0		3.75

(Th=50°C)

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W	L1	L2	H
72005/071/040B	4.0	10.1	83	21	29.8	29.8		4.00
72001/071/060B	6.0	10.1	83	32	29.8	29.8		3.50
72011/127/060B	6.0	18.1	83	57	29.7	29.7		3.50
720C1/127/060B	6.0	18.1	83	57	34.5	34.5		3.50
72001/127/060B	6.0	18.1	83	57	39.7	39.7		3.50
72001/241/060B	6.0	34.3	83	108	55.0	55.0		3.50
72031/133/070B	7.0	18.9	83	69	29.0	40.0		3.40
72001/071/085B	8.5	10.1	83	45	29.8	29.8		3.50
72001/127/085B	8.5	18.1	83	80	39.7	39.7		3.50
72001/097/090B	9.0	13.8	83	65	29.8	29.8		3.40
72011/063/100B	10.0	9.0	83	47	20.1	39.7		3.50
72001/127/100B	10.0	18.1	83	95	39.7	39.7		3.50
72001/127/110B	11.0	18.1	83	104	39.7	39.7		3.50
72011/129/150B	15.0	18.3	83	144	79.5	34.5		3.50
72041/071/150B	15.0	10.1	83	79	40.1	40.1		3.50
72008/131/150B	15.0	18.6	83	146	30.0	60.0		3.30
72018/242/160B	16.0	34.4	83	288	55.0	55.0	58.0	3.30

All TEMs are RoHS compliant

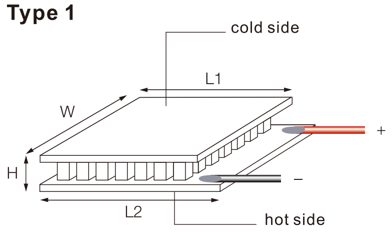
Thermal Cycling Modules

The Thermal Cycling Module series has been specifically designed for fast and very fast thermal cycling applications. Life time is significantly greater than a standard module under the same thermal cycling conditions. Typical application areas include PCR cyclers and analyzers. On request, these TEMs are available with different configurations, other dimensions and electrical specifications.

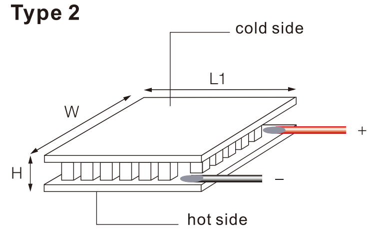
(Th=50°C)

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W	L1	L2	H
72013/127/030B	3.0	18.1	83	28	29.7	29.7		3.80
72013/127/040B	4.0	18.1	83	38	29.7	29.7		3.80
7200A/127/040B	4.0	18.1	83	38	39.7	39.7		4.50
72005/071/060B	6.0	10.1	83	32	29.8	29.8		4.00
72005/127/060B	6.0	18.1	83	57	39.7	39.7		4.00
72005/128/060B	6.0	18.2	83	57	39.7	39.7	42.8	4.00
72003/071/085B	8.5	10.1	83	45	29.8	29.8		3.80
72003/127/085B	8.5	18.1	83	80	39.7	39.7		3.80
7200A/031/090B	9.0	4.4	83	21	29.8	29.8		4.50
7201A/032/100B	10.0	4.5	83	24	25.4	25.4	28.7	4.50
7200A/031/150B	15.0	4.4	83	35	29.8	29.8		4.50
72013/032/150B	15.0	4.5	83	36	25.4	25.4	28.7	3.80
72058/199/160B	16.0	28.3	83	237	40.0	58.0		3.30

Type 1



Type 2



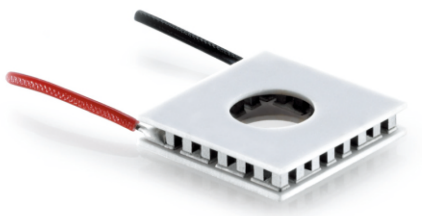
Type 1 TEMs feature a porch. This makes the L2 dimensions slightly longer than the L1 dimension.

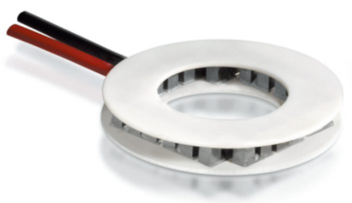
The following terms are used in the tables at Th=50℃:

Imax	Maximum input current in amperes at Qc=0 and ΔTmax
Vmax	Maximum DC input voltage in volts at Qc=0 and Imax
ΔTmax	Maximum temperature differential in ℃ at Qc=0 and Imax
Qcmax	Maximum heat pumping capacity in watts at Imax and ΔT=0
Th	Temperature of TEM hot side during operation

All TEMs are RoHS compliant

Center Hole Modules





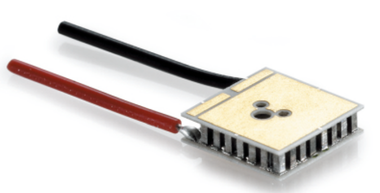
The Center Hole TEM series is suitable for various cooling and heating applications which generally require medium pumping capacity. Typical application areas include industrial and electrical equipment as well as laboratory and opto-electronics. Standard substrates are lapped with ±0.025 mm tolerance.

(Th=50°C)

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W	L1	D	H
Square Type								
20083/023/030B	3.0	3.3	83	5.1	15.1	15.1	5.0	2.90
20063/023/030B	3.0	3.3	83	5.1	15.1	15.1	6.7	2.90
20043/023/030B	3.0	3.3	83	5.1	18.0	18.0	8.0	2.90
20083/023/040B	4.0	3.3	83	6.8	15.1	15.1	5.0	2.90
20063/023/040B	4.0	3.3	83	6.8	15.1	15.1	6.7	2.90
20043/023/040B	4.0	3.3	83	6.8	18.0	18.0	8.0	2.90
20045/125/060B	6.0	17.8	83	56	39.7	39.7	4.7	3.55

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) DO	DI	H
Round Type							
20065/014/060B	6.0	2.0	83	6.3	26	14	3.1

Multi Hole Modules

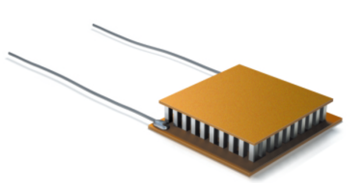


The Multi Hole TEM series has been specifically designed for ⌀5.6mm CAN type laser diodes. The increased contact area between the TEM and laser diode package enables more uniform cooling with the target temperature being achieved more rapidly. The optimized thermal contact area results in very stable thermal performance for laser diodes. 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.

(Th=50°C)

TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W	L	H
20073/023/012M	1.2	3.3	80	2.1	8.65	8.65	1.95

Thin Film Substrate Modules



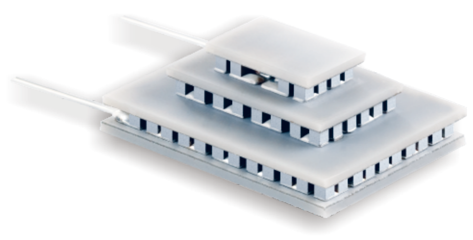
The Thin Film Substrate TEM series was specially developed to offer greater design flexibility to users.

Ferrotec Thin Film Substrate modules can be rapidly prototyped in nearly any shape. Features such as internal thermistors or custom external metallization patterns can be easily added. Copper heat sinks can be soldered directly on the substrate. The high performance polymer substrate is also available in many sizes.

* Only available on request

All TEMs are RoHS compliant

Multi Stage Modules



The Multi Stage TEM series is designed to provide significantly higher ΔT. These TEMs are suitable for low temperature applications where a small or medium cooling capacity is required. Typical application areas include IR-detectors, CCD arrays and electro-optics. These items are also available with different configurations in cascade designs to meet a range of deep cooling applications. They provide higher temperature differentials than obtainable with standard single stage TEMs.

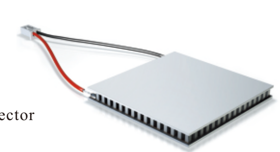
(Th=50°C)

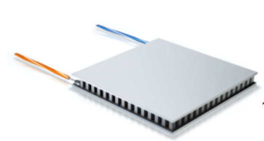
TEM Model No.	Imax (A)	Vmax (V)	ΔTmax (°C)	Qcmax (W)	SIZE(mm) W1	W2	W3	L1	L2	L3	H
2020/190/016BN	1.6	17.2	104	11	14.8	29.8		29.8	29.8		7.75
2020/038/048M	4.8	4.1	105	4.0	11.5	15.1		11.5	15.1		5.40
2020/110/050A	5.0	12.4	114	9.7	14.0	14.0		27.0	27.0		2.65
2020/088/055B	5.5	11.1	105	13	15.2	29.8		15.2	29.8		7.00
2020/147/055BN	5.5	9.2	95	23	25.0	30.0		25.0	30.0		4.74
2020/324/060BS	6.0	28.2	98	69	40.0	40.0		40.0	40.0		5.60
2020/185/065B	6.5	17.9	100	37	29.8	39.7		29.8	39.7		6.65
2020/197/070B	7.0	17.8	91	43	29.8	39.7		29.8	39.7		4.65
2020/157/070B	7.0	17.3	106	24	20.0	39.7		20.0	39.7		6.65
2020/197/080B	8.0	17.8	91	52	29.8	39.7		29.8	39.7		6.00
2020/094/230B	23.0	8.2	88	74	45.2	45.2		54.1	54.1		7.30
2030/099/043MN	4.3	8.1	117	6.1	8.6	12.7	21.7	13.0	19.4	28.3	10.40
2030/119/045B	4.5	8.6	111	9.7	15.2	20.0	29.8	15.2	20.0	29.8	9.10
2030/228/045B	4.5	16.4	111	18	20.0	29.8	39.7	20.0	29.8	39.7	9.50
2030/106/047MN	4.7	9.3	123	7.0	8.6	13.0	21.7	13.0	21.9	28.3	8.42
2030/106/055A	5.5	9.6	111	8.7	8.6	13.0	21.7	13.0	21.9	28.3	6.75
2030/228/060B	6.0	18.3	111	22	20.0	29.8	39.7	20.0	29.8	39.7	8.55

Customized Modules

Ferrotec can offer modifications for a complete custom designed TEM, in terms of size, shape, substrate materials or metallization. Please contact Ferrotec with your specific design requirements.

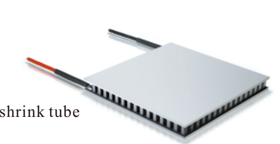
TEM with connector

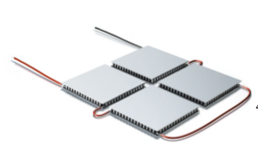




TEM with custom lead wires

TEM with heat shrink tube





4 linked TEMs

All TEMs are
RoHS
compliant

TEM Option: RTV Silicone Seal

Ferrotec offers an electronics-grade silicone as an option for perimeter sealing TEMs. This RTV Silicone Seal is an effective barrier against condensation when operating TEMs below the dew point.
Continual moisture contact within the TEM can lead to performance degradation. The RTV Silicone Seal is flexible after setting and retains its elasticity over time, this property is particularly useful in rigorous, temperature cycling applications. Ferrotec RTV Silicone Seal is effective over a temperature range of -60℃ to +200℃. The impact of the RTV Silicone Seal on cooling performance is depending on the design of the assembly.

TEM Option: Epoxy Seal

Epoxy sealing is offered for protecting TEMs used in high humidity environments. Although RTV silicone sealing has been demonstrated to be an effective moisture barrier, our epoxy sealant offers greater moisture resistance for those applications requiring the highest protection. Ferrotec has carefully screened and tested many epoxy types to develop the most effective solution for TEMs. Brittleness is a common problem with some epoxies used to seal TEMs, and it can lead to separation from the substrate over time and cause loss of seal. Ferrotec epoxy sealant forms a strong bond with the substrate and remains flexible after curing, therefore avoiding this common problem. This epoxy has also demonstrated very good resistance to humidity under aggressive thermal cycling testing. The maximum recommended operating temperature for the epoxy sealant is 80℃. Ferrotec epoxy sealant can be applied to nearly all TEM types. The impact of the epoxy on cooling performance is depending on the design of the assembly.

All TEMs are
RoHS
compliant

TEM Standard Assembly

The FTA951 is a standard cold plate assembly, suitable as a building set for all kinds of cooling and heating applications.

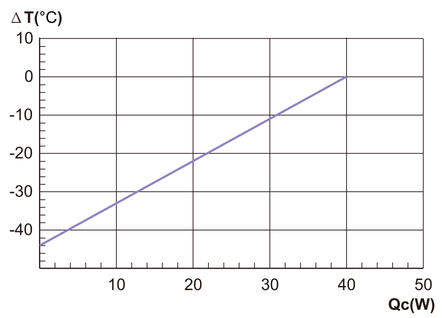
Features:

1. Includes a unique airtight sealing structure which minimizes moisture permeation.
2. Cooling performance is optimized through the use of a high efficiency heat sink.
3. The assembly design isolates the TEM from shock and vibrations, increasing reliability.
4. The assembly includes a high reliability DC fan to ease integration with existing equipment.
5. With several unique features in this assembly design, a patent is pending.

Examples of Typical Applications:

Compact Refrigerators, Cooled/Heated Compact Cases, Testing Stands, Dehumidifiers, Scientific Instrumentation and others.

Performance



ΔT = Tc - Ta (°C)

Ta = Ambient temperature

Tc = The temperature of the TEM Standard Assembly surface

Specification (Th=50°C)

TEM Model No.	V (V)	I (A)	Imax (A)	Qcmax (W)	SIZE(mm) W x L x H	Dim. Cooling Plate (mm) W x L
FTA951	12(DC)	5.8	7.0	39	122 x 100 x 102	80 x 80

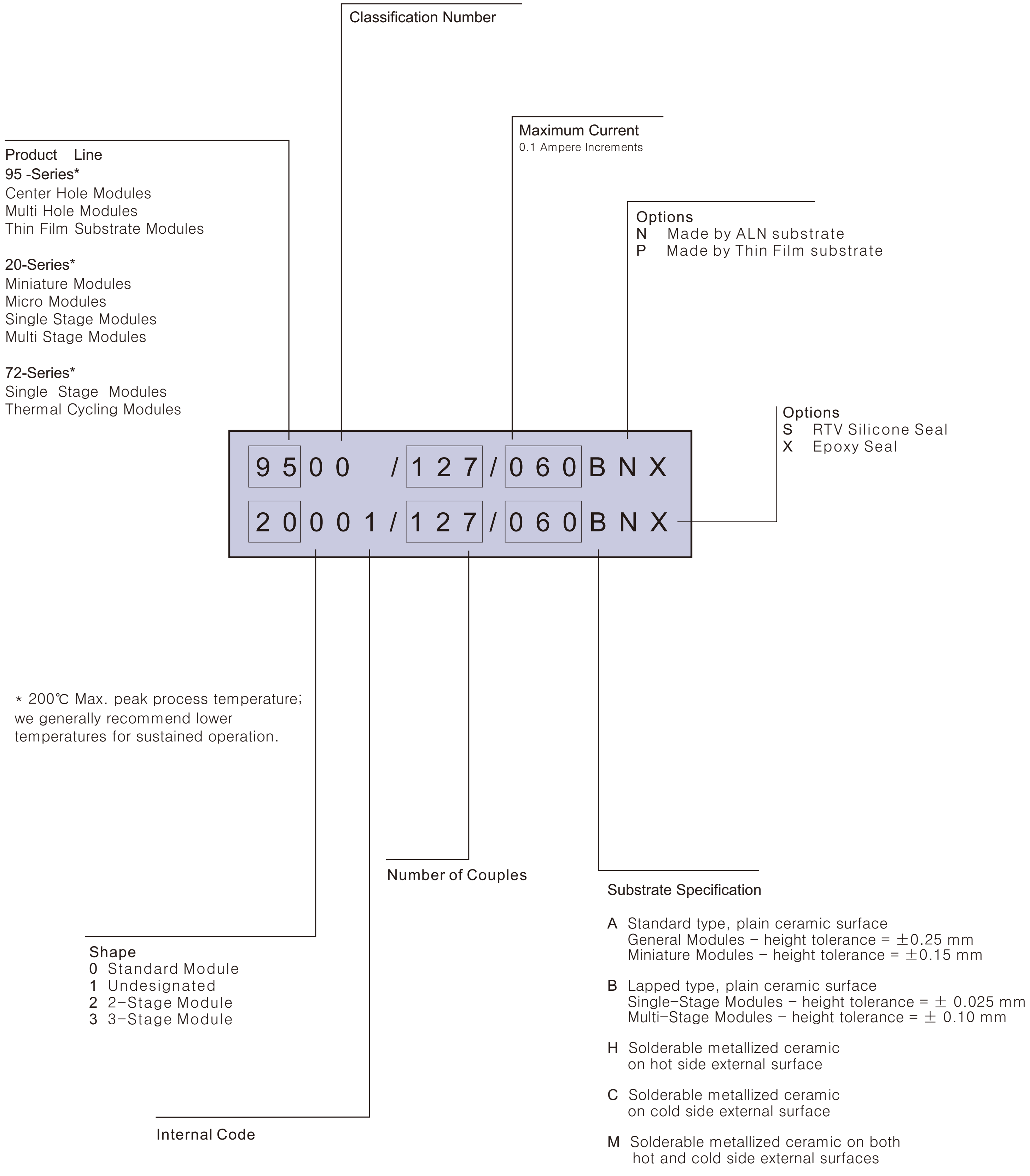
V = Rated Voltage (V)
I = Rated Current (A)
Imax = Maximum Current (A)
Qc = Heat Pumping Capacity (W)

DC Fan Rated Voltage/Current=DC12V/0,24A
Ambient Temp.: Ta = 25℃,
Cooling Block Temp: Tc = 25℃
Temp. Differential (Ta = Th = Tc): T = 0℃

The figures seen in the above performance table chart reflect average values.
Testing was performed with the cooling plate surrounded by insulation.
The dimensions do not include the side terminal. Mechanical drawing available on request.
The standard configuration includes a heat insulation package.

All TEMs are RoHS compliant

TEM Numbering System



All TEMs are RoHS compliant

Customer Request Form

In order to help you optimize the selection of a TEM we have provided the following list of questions. Since the performance of a TEM is strongly dependant on all system components, summarizing your application requirements will help us to provide a complete and effective solution for you.

Please fax or e-mail the completed form to the appropriate Ferrotec sales office in your region.

Contact Information

Customer

Name

Position

Title

Company

Street/Address

City

State/Province

Country

Phone

E-Mail

Application Requirements

Type of Application

(cooling only,cooling and heating, power generation), please describe:

Performance Needs

- ☐ Total Heat Load (active + passive)
- ☐ Max. Ambient Temperature
- ☐ Targeted Cold Temperature
- ☐ Targeted Hot Temperature
- ☐ Rate of cooling required
- ☐ Rate of heating required

Physical Details of Thermoelectric Subassembly

Overall Dimensional Envelope

Width:

Depth:

Height:

Weight:

Hot Side

Heat Sink Type:

Fan Size and Flow Rate (CFM):

Heat Sink Thermal Resistance (℃/W):

Cold Side

Component Type (describe component being cooled, e.g., heat sink, liquid plate, solid plate):

Component Dimensions (in mm or inches):

Heat Sink Thermal Resistance (℃/W):

Environmental

Describe any special exposure requirements, e. g., high humidity, vacuum

Hot Side:

Cold Side:

Describe any special mechanical requirements, high vibrations, G-forces, etc.

Electrical Requirements

Total Power In:

Voltage (target, maximum):

Current (target, maximum):

Specific Module Requirements

Specific Module Dimensions

Stage:

Length:

Width:

Height:

Other:

Substrate Requirements

Type(96%alumina, AlN):

Thickness:

Hot Side Sectioning:

Other:

Wire Leads / Termination

- ☐ Teflon Insulated Multistrand (standard)
- ☐ Special Lead Length
- ☐ Tinned solid Wire
- ☐ Posts (specify)
- ☐ Special Terminals (specify)

External Substrate Surface

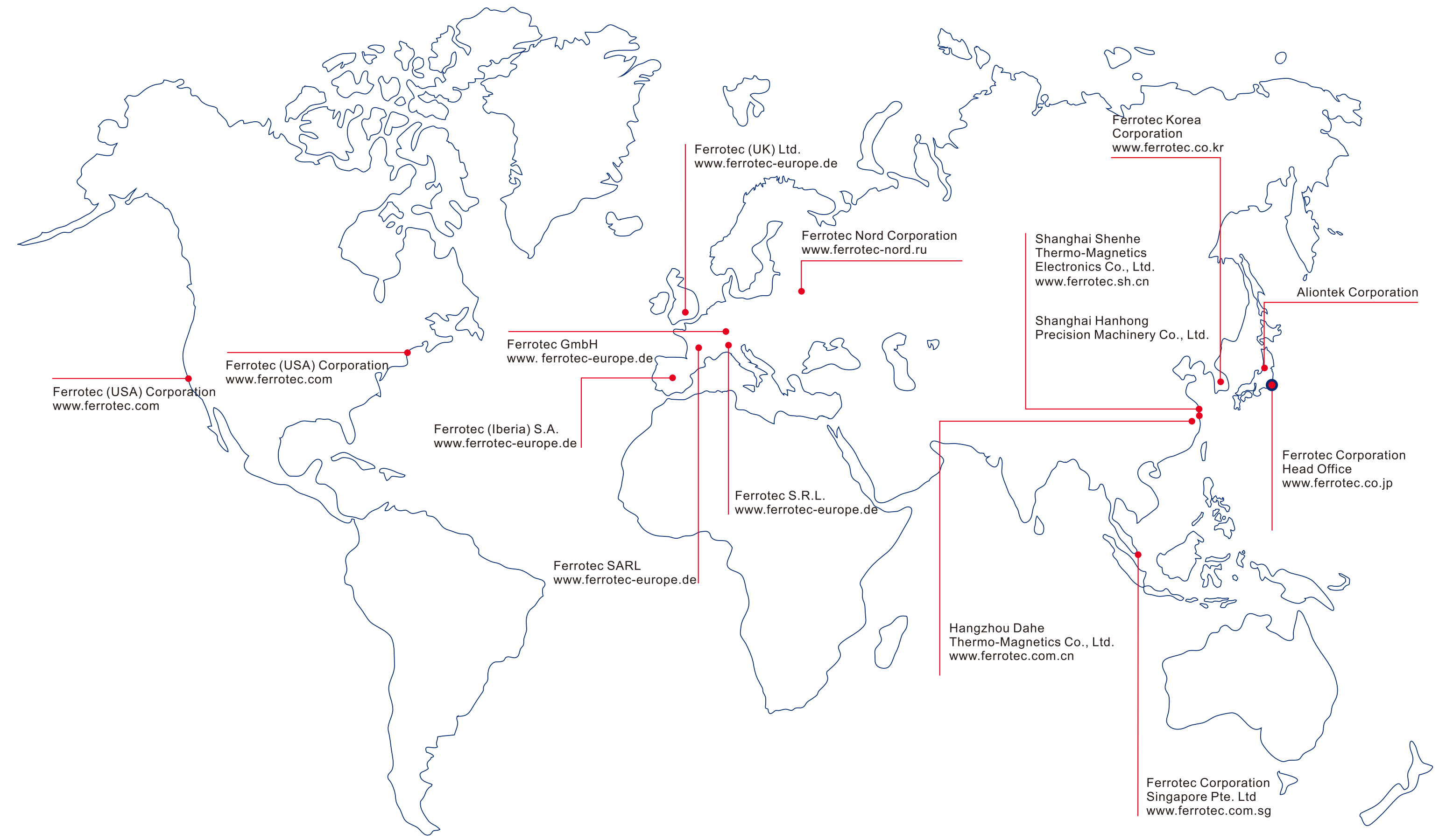
- ☐ Bare Ceramic
- ☐ Metalized:
  - ☐ Copper
  - ☐ Copper ☐ Nickel ☐ Gold
- ☐ Specific gold thickness
- ☐ ORe side metallization only
- ☐ Specific metallization pattern

Pre-Tinning Options

☐ Hot Side ☐ Cold Side ☐ Both Sides

- ☐ 118℃ InSn
- ☐ 138℃ BiSn

Special Module Requirements



Applications of TEM

For example:

Automotive
- Heated and cooled seats

Semiconductor
- Chiller
- Circulator
- Cooling plate / chuck

Biomedical
- Blood analyzer
- PCR
- Specimen temperature cycling

Scientific
- Circulator
- Dehumidifier
- Spectrophotometer

Optical
- Charged couple device (CCD) cooling
- Infrared detectors
- Laser diode cooling
- Photo diode cooling
- SHG laser cooling

Computer
- CPU Cooling
- Chip-set burn-in

Consumer
- Cooler box
- Mini refrigerator
- Beverage cooler /heater
- Wine cooler

Industrial / Commercial
- Waste heat power generation
- Remote power generation

Please contact us using the Customer Request Form