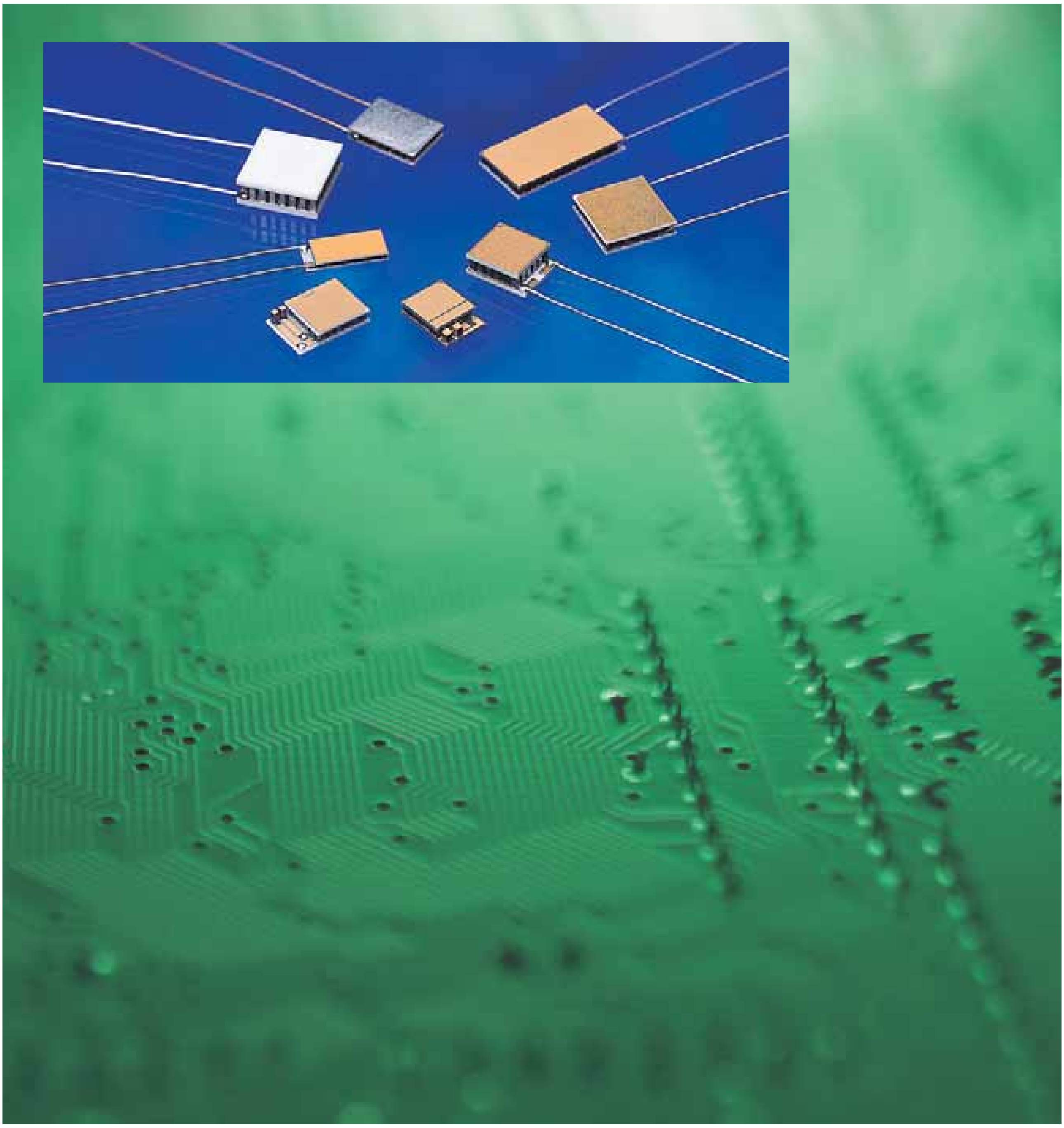
KOMATSU

THERMO-MODULE



KELK LTD.

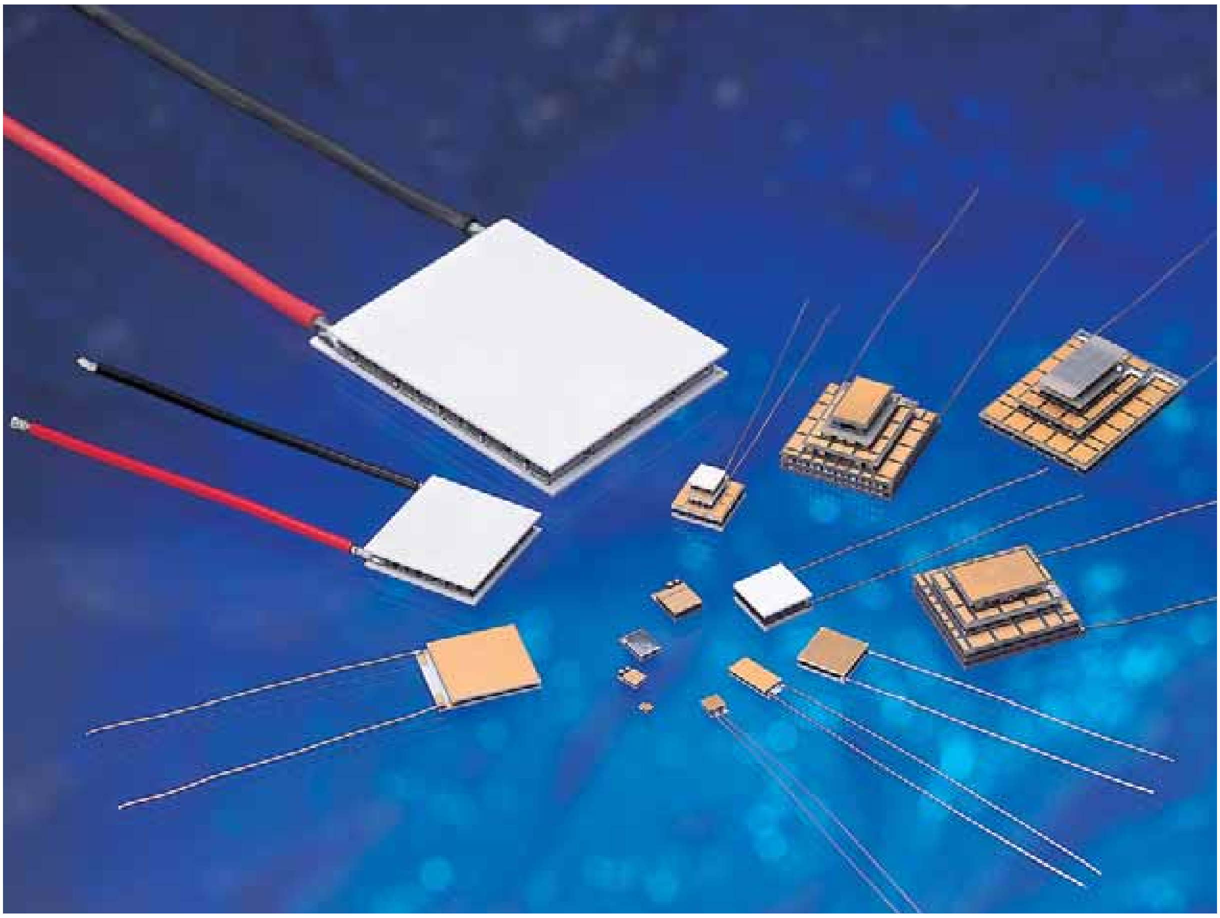
KELK THERMO-MODULE

The thermo-module is used in a wide range of applications where such merits as small, lightweight solid state device with no moving parts and as superiority in temperature controlling are much appreciated. Meanwhile it is a well-known fact that the thermo-module, especially in cooling mode, has lower energy efficiency compared to the compressor refrigerator having similar functions as the former. However, it is a fact too, that there are a lot of products to which the thermo-module is indispensable. We are confident that the thermo-module is promised to be applied for more and more products in future.

Since 1960 our company has been producing the Thermo-modules with melt-grown bismuth telluride semiconductor, and has been improving the performance and reliability of them along with, focusing mainly on the semiconductor process, developing many applied equipment and systems in which precise temperature control had been an indispensable requirement.

Since 1988, we have been supplying micro-modules, with high strength, sintered thermoelements, to the fiber-optic telecommunication industry all over the world. Moreover, since 1997, we have been mass-producing the "Z-material", having world-best performance in production, made by an innovative hot-forging process.

Therefore, our company not only has an expertise related to element production and assembly of the discrete Thermo-module, but also has one obtained from actual applications in a wide range of products. We vow to answer our client's continuously intensifying needs by offering higher performance, more reliable and cost efficient thermo-modules created in a future-looking research and development.



Advantages of KELK Thermo-module

● Abundant standard models and flexible response to special requirements

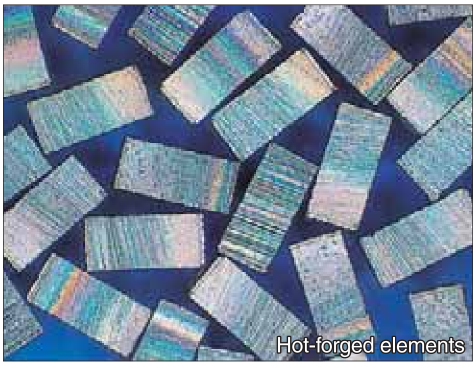
KELK provides a broad range of thermo-electric cooler products, in response to the varied requests of our customers. KELK offers various kinds of TECs, including multi-purpose TECs with mass-volume reliability, and multi-stage TECs with high Delta-T. We also offer micro-modules and MiniTECs with high performance & reliability, using element material with world-beating performance and Delta-T. When custom-designs are requested, we can propose the optimal design based on our extensive experience.

Assembly robot

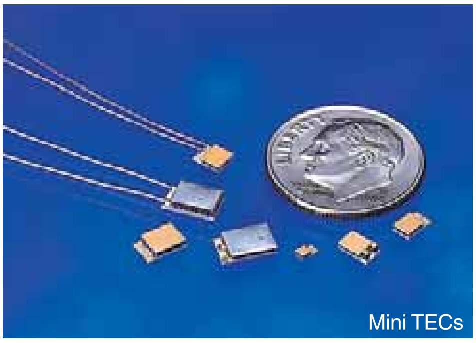
● Advantage of Micro-module

Excellent & consistent performance with high reliability

All of KELK's micro-modules use hot-forged elements with the world's highest performance; our company developed these exclusively, and they are assembled using robotic automation. Compared with meltgrown elements, KELK's hot-forged elements are highly efficient, have very good mechanical strength, do not chip and have homogeneous consistency.
The high efficiency of our element material, together with our precision automated assembly process, results in micro-modules with high performance, consistent mass volume reliability, and excellent cost/performance.
We have a wide range of different product types, such as Enhanced series for high power, two-stage series for high Delta-T, and MiniTEC series for small footprint.



Hot-forged elements



Mini TECs

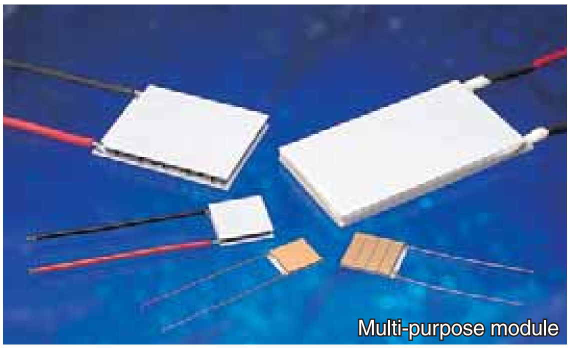
Visual inspection

Note : All micro-modules are 100%-Screened by the Bellcore Standard plus 100% visually inspected under the microscope.

● Advantage of multi-purpose module

·High reliability by 100% screening
·Hot-forged material is available for larger △T or smaller power consumption

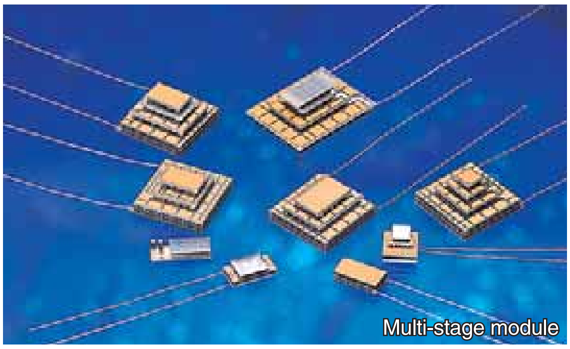
We use melt-grown element to assemble Multi-purpose module and conduct 100% screening (accept/reject inspection) by applying current, which promises high reliability. Meanwhile we newly developed special models having a long life for thermal cycling. For a larger △T or a smaller power consumption application, the high performance "Hot-forged material" is also available.



Multi-purpose module

● Advantage of multi-stage module

Multi-stage module assembled with hot-forged elements. Therefore, these modules have similar advantages as micro-module does. The latter uses AlN ceramics as the standard and has very low profile to improve resistance against shock and vibration.



Multi-stage module

Table 1 Micro Modules

Type	Series	Model No.	Imax(A)	**V max**(volts)			**ΔT max**(℃)			**Qc max**(watts)		
				Thj= 27℃	Thj= 50℃	Thj= 70℃	Thj= 27℃	Thj= 50℃	Thj= 70℃	Thj= 27℃	Thj= 50℃	Thj= 70℃
Single-stage Standard	ML	KSML007	1.5	0.8	0.9	1.0	75	85	93	0.7	0.8	0.9
		KSML012	↑	1.4	1.6	1.8	↑	↑	↑	1.3	1.4	1.5
		KSML018	↑	2.2	2.4	2.7	↑	↑	↑	1.9	2.1	2.2
		KSML023	↑	2.8	3.1	3.4	↑	↑	↑	2.4	2.6	2.9
		KSML029	↑	3.5	3.9	4.3	↑	↑	↑	3.0	3.3	3.6
		KSML031	↑	3.7	4.2	4.6	↑	↑	↑	3.2	3.5	3.8
		KSML035	↑	4.2	4.7	5.2	↑	↑	↑	3.7	4.0	4.3
		KSML047	↑	5.7	6.4	7.0	↑	↑	↑	4.9	5.4	5.8
	MH	KSMH007	2.0	0.7	0.9	1.0	75	85	93	0.9	1.1	1.2
		KSMH012	↑	1.4	1.6	1.7	↑	↑	↑	1.7	1.9	2.0
		KSMH018	↑	2.1	2.4	2.6	↑	↑	↑	2.6	2.8	3.1
		KSMH023	↑	2.7	3.1	3.3	↑	↑	↑	3.2	3.6	3.9
		KSMH029	↑	3.4	3.8	4.2	↑	↑	↑	4.1	4.5	4.9
		KSMH031	↑	3.7	4.1	4.5	↑	↑	↑	4.4	4.8	5.2
		KSMH035	↑	4.1	4.6	5.1	↑	↑	↑	4.9	5.4	5.9
		KSMH047	↑	5.5	6.2	6.8	↑	↑	↑	6.6	7.3	7.9
	EH	KSEH007	2.4	0.8	0.9	1.0	75	85	93	1.2	1.3	1.4
		KSEH012	↑	1.4	1.6	1.8	↑	↑	↑	2.0	2.2	2.4
		KSEH018	↑	2.1	2.4	2.6	↑	↑	↑	3.0	3.3	3.6
		KSEH023	↑	2.8	3.1	3.4	↑	↑	↑	3.8	4.1	4.5
		KSEH029	↑	3.5	3.9	4.3	↑	↑	↑	4.8	5.2	5.7
		KSEH031	↑	3.7	4.2	4.6	↑	↑	↑	5.1	5.6	6.1
		KSEH035	↑	4.2	4.7	5.2	↑	↑	↑	5.8	6.3	6.8
		KSEH047	↑	5.7	6.4	7.0	↑	↑	↑	7.7	8.5	9.2
Two-stage	EH	K2M006	2.6	0.9	1.0	1.1	97	109	120	0.8	0.9	1.0
		K2M010	↑	1.4	1.6	1.7	96	108	118	1.3	1.4	1.5
		K2M016	↑	2.2	2.5	2.7	96	108	118	2.0	2.2	2.4
		K2M022	↑	3.0	3.4	3.7	95	107	117	2.7	3.0	3.2
		K2M028	↑	3.8	4.3	4.7	95	107	117	3.4	3.7	4.0
		K2M030	↑	4.1	4.6	5.1	95	107	117	3.5	3.9	4.2
		K2M034	↑	4.6	5.2	5.7	94	106	116	4.1	4.5	4.9
MiniTECs	AL	KSAL008	1.5	0.9	1.0	1.1	72.5	82	90	0.9	1.0	1.1
		KSAL012	↑	1.4	1.5	1.7	↑	↑	↑	1.3	1.4	1.6
		KSAL018	↑	2.1	2.3	2.5	↑	↑	↑	2.0	2.2	2.3
		KSAL023	↑	2.6	2.9	3.2	↑	↑	↑	2.5	2.7	3.0
	AH	KSAH008	2.0	0.9	1.1	1.2	71	80.5	88.5	1.1	1.2	1.3
		KSAH012	↑	1.4	1.6	1.7	↑	↑	↑	1.7	1.8	2.0
		KSAH018	↑	2.1	2.4	2.6	↑	↑	↑	2.5	2.8	3.0
		KSAH023	↑	2.7	3.1	3.4	↑	↑	↑	3.2	3.5	3.8

- All modules are screened by the following processes with the ACR change criterion of ±2%.
  Thermal Shock : -40/85℃ Temperature Cycling
- Two-stage type modules are designed for relatively higher ΔT application.
- Footprint of MiniTECs is 50-75% smaller than that of standard TECs.
- Explanation of Imax,Vmax, ΔTmax and Qmax are described in page 10.

- Dimensions of these products are "original" specification created by Komatsu Electronics Inc..

Model No.	Top ceramics W (mm)	Top ceramics L (mm)	Bottom ceramics W (mm)	Bottom ceramics L (mm)	Height H (mm)	Height tolerance (±mm)	Pb-free
KSML007	4.4	4.4	4.4	4.4	2.02	0.1	○
KSML012	4.3	6.5	4.3	7.6	2.02	↑	○
KSML018	6.0	6.2	6.0	7.2	2.02	↑	○
KSML023	6.0	8.2	6.0	8.2	2.02	↑	○
KSML029	6.0	10.2	6.0	10.2	2.02	↑	○
KSML031	8.0	8.0	8.0	8.0	2.02	↑	○
KSML035	6.0	12.2	6.0	12.2	2.02	↑	○
KSML047	8.0	12.2	8.0	12.2	2.02	↑	○
KSMH007	4.4	4.4	4.4	4.4	1.65	0.1	○
KSMH012	4.3	6.5	4.3	7.6	1.65	↑	○
KSMH018	6.0	6.2	6.0	7.2	1.65	↑	○
KSMH023	6.0	8.2	6.0	8.2	1.65	↑	○
KSMH029	6.0	10.2	6.0	10.2	1.65	↑	○
KSMH031	8.0	8.0	8.0	8.0	1.65	↑	○
KSMH035	6.0	12.2	6.0	12.2	1.65	↑	○
KSMH047	8.0	12.2	8.0	12.2	1.65	↑	○
KSEH007	4.4	4.4	4.4	4.4	1.65	0.1	○
KSEH012	4.3	6.5	4.3	7.6	1.65	↑	○
KSEH018	6.0	6.2	6.0	7.2	1.65	↑	○
KSEH023	6.0	8.2	6.0	8.2	1.65	↑	○
KSEH029	6.0	10.2	6.0	10.2	1.65	↑	○
KSEH031	8.0	8.0	8.0	8.0	1.65	↑	○
KSEH035	6.0	12.2	6.0	12.2	1.65	↑	○
KSEH047	8.0	12.2	8.0	12.2	1.65	↑	○
K2M006	4.05	4.05	4.05	4.05	3.0	0.2	○
K2M010	4.05	6.05	4.05	6.05	3.0	↑	○
K2M016	6.05	6.25	6.05	6.25	3.0	↑	○
K2M022	6.05	8.25	6.05	8.25	3.0	↑	○
K2M028	6.05	10.25	6.05	10.25	3.0	↑	○
K2M030	8.05	8.05	8.05	8.05	3.0	↑	○
K2M034	6.05	12.05	6.05	12.05	3.0	↑	○
KSAL008	2.56	2.56	2.56	3.56	1.1	0.1	○
KSAL012	2.56	3.8	2.56	4.8	1.1	↑	○
KSAL018	3.8	3.8	3.8	4.8	1.1	↑	○
KSAL023	3.8	5.04	3.8	6.04	1.1	↑	○
KSAH008	2.56	2.56	2.56	3.56	0.97	0.1	○
KSAH012	2.56	3.8	2.56	4.8	0.97	↑	○
KSAH018	3.8	3.8	3.8	4.8	0.97	↑	○
KSAH023	3.8	5.04	3.8	6.04	0.97	↑	○

Other Specifications

1) Ceramics
All models can be assembled with alumina &/or aluminum nitride ceramics. (AL/AH series is excluded)

2) Metallization
Standard metallization is CuNiAu with Au thickness of 0.25 μm

3) Assembly solder
SnSb(232℃) or AuSn(280℃) is available for assembly solder.
However, the assembly solder of the model KSML047/KSMH047/KSEH047 Two-stage are SnSb solder.

4) InSn (117℃), BiSn (138℃) SnAgCu (217℃) or SnSb (232℃) are available for pretinning solder.
Other solders specified by customers are also available. (Solder volume control is available.)

5) ΔTmax is measured in vacuum of 0.13Pa
(ΔTmax in air or nitrogen is 5 to 6 ℃ lower than that in vacuum.)

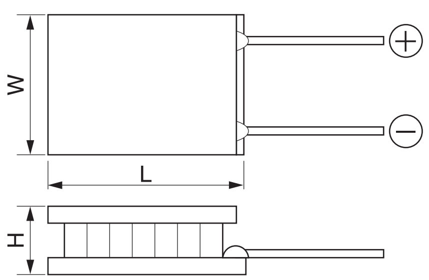


Table 2 Multi-purpose & Multi-stage Modules

Type	Model No.	Imax(A)	V max(volts)			ΔT max(℃)			Qc max(watts)		
			Thj= 27℃	Thj= 50℃	Thj= 70℃	Thj= 27℃	Thj= 50℃	Thj= 70℃	Thj= 27℃	Thj= 50℃	Thj= 70℃
Multi-purpose module	KSM-04007C	4.0	0.8	0.9	1.0	64	73	81	2.0	2.2	2.5
	KSM-04017C	↑	2.0	2.2	2.5	↑	↑	↑	4.8	5.4	6.0
	KSM-04031C	↑	3.6	4.1	4.5	↑	↑	↑	8.7	9.9	10.9
	KSM-04071C	↑	8.3	9.2	10.2	↑	↑	↑	19.9	22.6	24.9
	KSM-04127C	↑	14.8	16.7	18.3	↑	↑	↑	35.6	40.4	44.5
	KSM-06007C	6.0	0.8	0.9	1.0	↑	↑	↑	3.0	3.4	3.7
	KSM-06017C	↑	2.0	2.2	2.4	↑	↑	↑	7.2	8.2	9.0
	KSM-06031C	↑	3.6	4.1	4.5	↑	↑	↑	13.1	14.9	16.4
	KSM-06071C	↑	8.3	9.2	10.2	↑	↑	↑	30.0	34.1	37.6
	KSM-06127C	↑	14.7	16.5	18.2	↑	↑	↑	53.8	61.0	67.2
	KSM-09007C	9.0	0.8	0.9	1.0	↑	↑	↑	4.5	5.1	5.6
	KSM-09017C	↑	2.0	2.2	2.4	↑	↑	↑	10.8	12.3	13.5
	KSM-09031C	↑	3.6	4.0	4.4	↑	↑	↑	19.7	22.4	24.6
	KSM-09071C	↑	8.3	9.2	10.2	↑	↑	↑	45.2	51.2	56.4
Multi-stage module	K2M-01004	1.6	1.3	1.5	1.7	101.0	114.0	125.0	0.6	0.7	0.7
	K2M-01011	1.6	3.8	4.3	4.7	101.0	114.0	125.0	1.7	1.8	2.0
	K3M-01002	1.7	2.1	2.3	2.6	124.0	140.0	153.0	0.4	0.5	0.5
	K3M-01004	1.5	3.8	4.2	4.7	120.0	136.0	149.0	0.7	0.8	0.8
	K4MA010	4.6	14.9	16.7	18.3	124.0	140.0	154.0	6.3	7.0	7.6
	K4MB005	5.3	16.1	18.0	19.8	131.0	148.0	162.0	4.0	4.3	4.6
	K5MA004	4.6	15.0	16.8	18.4	136.0	153.0	168.0	2.9	3.2	3.4
	K5MB002	5.2	16.0	18.0	19.7	143.0	161.0	176.0	1.7	1.8	2.0
	K3MC004	5.0	7.4	8.3	9.1	111.0	126.0	139.0	6.5	7.2	7.8
	K4MC005	4.6	14.9	8.0	8.7	124.0	140.0	154.0	3.2	3.5	3.8

■ Multi-purpose module:

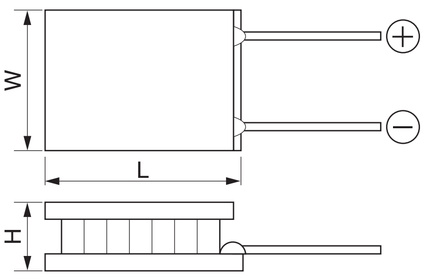
1. △Tmax is described as the value in air.
2. 100% screened.
3. Pb-free, fatigue-resistant SnAgCu(melting point:217℃) is used as the assembly solder.
4. ±0.025mm height allowance is available by lapping.

■ Multi-stage module:

1. High performance hot-forged element is used.
2. SnSb (melting point:232℃) or SnAgCu (melting point:217℃) is used as the assembly solder.
3. △Tmax is described as the value in vacuum of 0.13Pa..
4. InSn is available for pretinning solder. Pretinning is only on hot side.

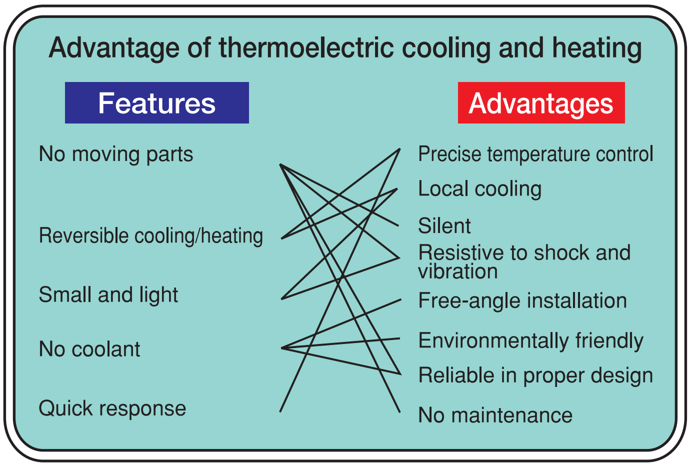
■ Explanation of Imax,Vmax, △Tmax and Qmax are described in page 10.

Model No.	Top ceramics		Bottom ceramics		Height	Height tolerance	Ceramic material	Metallization		Pb-free
	W (mm)	L (mm)	W (mm)	L (mm)	H (mm)	(±mm)		Nil	Cu-Ni-Au (Pretinning)	
KSM-04007C	10.3	10.3	10.3	12.2	4.65	0.15	Alumina	○		○
KSM-04017C	15.0	15.0	15.0	17.0	4.65	↑		○		○
KSM-04031C	20.0	20.0	20.0	22.0	4.65	↑		○		○
KSM-04071C	30.0	30.0	30.0	31.5	4.65	↑		○		○
KSM-04127C	40.0	40.0	40.0	41.5	4.65	↑		○		○
KSM-06007C	10.3	10.3	10.3	12.2	3.8	↑	Alumina	○		○
KSM-06017C	15.0	15.0	15.0	17.0	3.8	↑		○		○
KSM-06031C	20.0	20.0	20.0	22.0	3.8	↑		○		○
KSM-06071C	30.0	30.0	30.0	31.5	3.8	↑		○		○
KSM-06127C	40.0	40.0	40.0	41.5	3.8	↑		○		○
KSM-09007C	15.0	15.0	15.0	15.0	5.5	↑	Alumina	○		○
KSM-09017C	22.0	22.0	22.0	22.0	5.5	↑		○		○
KSM-09031C	30.0	30.0	30.0	30.0	5.5	↑		○		○
KSM-09071C	44.0	44.0	44.0	44.0	5.5	↑		○		○
K2M-01004	4.4	4.4	4.4	6.6	4.5	0.2	Alumina	○		○
K2M-01011	4.4	6.6	8.7	8.7	4.5	0.2		○		○
K3M-01002	3.0	3.0	6.0	6.0	4.3	0.3			○	○
K3M-01004	4.4	4.4	8.7	8.7	6.5	0.3		○		○
K4MA010	8.5	13.0	19.25	20.75	8.2	0.5	Aluminum nitride (AIN)		○	○
K4MB005	6.6	11.0	19.25	20.75	8.2	0.5			○	○
K5MA004	6.6	11.0	19.25	20.75	10.3	0.5			○	○
K5MB002	5.3	5.3	19.25	20.75	10.3	0.5			○	○
K3MC004	8.5	13.0	21.5	28.0	7.3	0.4	Aluminum nitride (AIN)			○
K4MC005	6.6	11.0	21.5	28.0	9.4	0.5				○



Application of Thermo-module

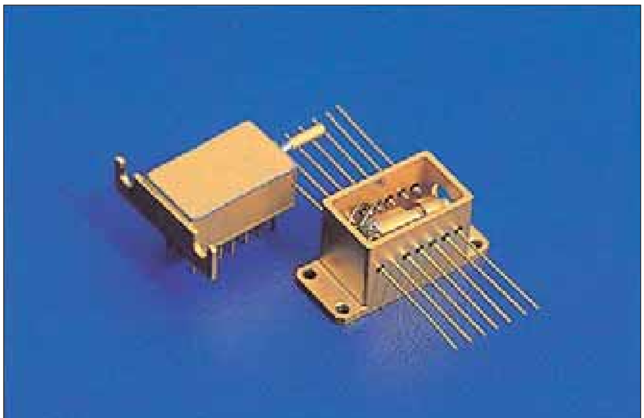
The inherent advantages of thermo-module are : a small, solid -state device, can easily do precise cool/heat control only by applying current, has a relatively wide operating temperature of −100 to 100℃, and is very reliable when properly used.
There could be extensive applications to utilize these advantages, and thermo-module is actually used in very wide range of equipment and devices. Typical examples can be found in semiconductor process equipment inevitably requiring precise temperature control, and wavelength control of laser diodes for fiber-optic telecommunication.



●Application Examples

Fiber-optic Telecommunication

- Transmiter Laser
- EDFA Pump Laser
- APD Receiver


Laser Package

Semiconductor Process

- Cooling Plate ・Circulator
- Chemical Circulator
- Precision Air Conditioning Unit


Cooling Plate

Sensors

- Infared Detector
- High Sensitivity CCD
- Photo Multiplier


Infrared Sensor

Miscellaneous

- Isothermal Bath
- Dehumidifier
- Cooler Box
- Isothermal Plate
- Gene Amplifier


Isothermal Plate

Principle of Thermoelectric Cooling/Heating and Structure of Thermo-module

● Principle of Cooling/Heating

The thermo-module is a sort of heatpump made by thermo-electric semiconductor. The physical phenomenon used here, as a principle, is shown in right Fig. 1. Two kind of thermoelectric semiconductors, which are made of the 'P-type' and 'N-type' element, are electrically connected with a metallic strip to form a π-type series circuit called 'P-N couple'. When a current is applied to N→P direction heat absorption occurs at the top of π, and heat generates at the bottom. Thus, as the result of the Peltier effect, heat is pumped from the top to the bottom.
The above phenomenon is better explained as follows. At the top of the π, where electrons move P→N direction, the current conversely runs N→P, electrons transfer in their energy state to a higher level absorbing the vibration energy from the surrounding crystal lattice lowering temperature of the top. Meanwhile, at the bottom of the π, where electrons go N→P direction and the current flows vice verse, electrons having absorbed lattice vibration energy at the cold side transfer their low energy state to a higher one. In this process, the electron gives their excess energy to the surrounding lattice increasing the vibration energy, which results in a temperature rise.
Heat absorption by the Peltier effect increases in proportion to the applied current however the Joule heat originated from the internal electrical resistance soars in proportion to a square of the current. As the result, there exists maximum absorption point of heat at a corresponding current. Excess current harms heat absorption on the contrary.

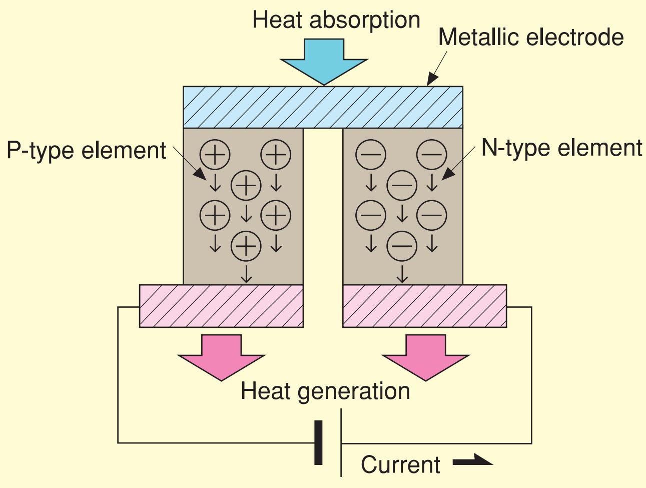


Fig.1 Principle of Thermoelectric Cooling/Heating

● Single-stage module and its structure

A single-stage module is made by sandwiching the element couples between the two ceramic plates with the electrode metal to make a series circuit(Fig.2). The number of the element couples in a module ranges from several to over one hundred. In proportion to the number of couples, the heat absorption(or heat generation) of the module increases. The hot side of the module requires a heat-sink for radiating heat : the total quantity of heat load at the cold side plus the power consumption. For a heat-sink, air-cooled fins or water-cooled plates are used. Ceramic pads at both sides must make thermally well conducting interfaces with head-load and heat-sink.

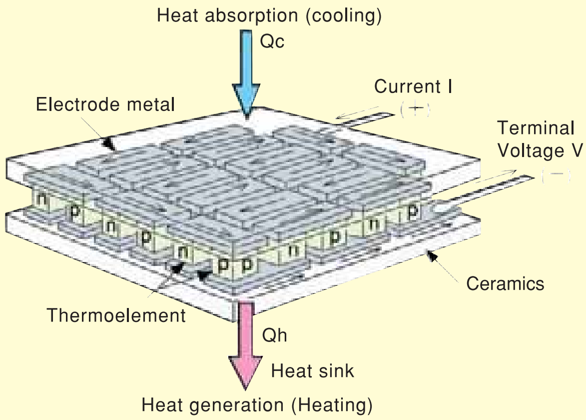


Fig.2 Single-stage Module

● Multi-stage module and its structure

When the cold side temperature is 27℃, the maximum temperature difference between the cold and the hot side of a single-stage module is about 68℃. However, in a multi-stage module, a large temperature difference can be obtained. The 5-stage module in Fig.3 can give a maximum temperature difference of 123℃.(All in vacuum)
The multi-stage module can achieve a big temperature difference by a pyramid shape configuration. Because it is necessary for a lower stage to absorb the heat influx from an upper stage while obtaining positive temperature difference between the two stages.
When the temperature difference is very large the heat absorption capacity significantly decreases. Therefore vacuum container is commonly used to avoid thermal convection and conduction of the atmosphere. When the cold side temperature go down to around −100℃, radiation effect from the surroundings become large enough for the cold side to have to have a shield. Six-stage is a usual maximum number of stages because, below −100℃, the performance of the thermo-element significantly degrades.

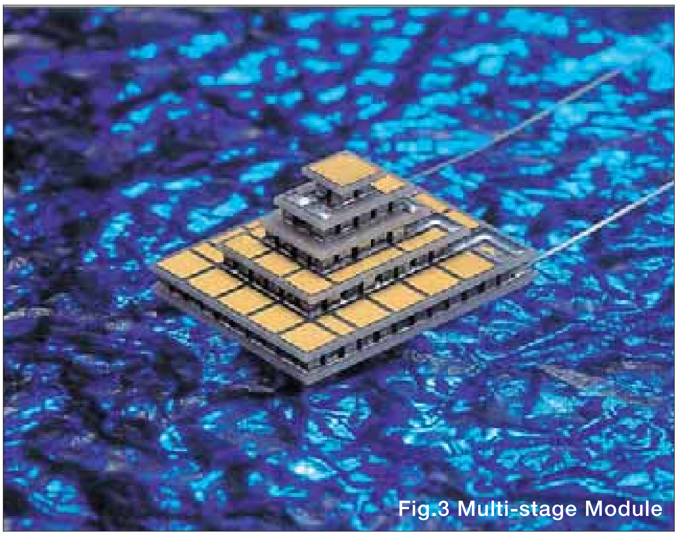


Fig.3 Multi-stage Module

How to Select and Use Thermo-module

Performance Parameters and Performance Diagram

In Table 1 (page 4) the following parameters are shown to describe performance characteristics of thermo-modules.

Imax : Maximum current -------------- Current at ΔTmax, Qc=0
Vmax : Maximum terminal voltage ---------- Terminal voltage at Imax, ΔTmax and Qc=0
ΔTmax : Maximum temperature difference ---- Temperature difference between the cold side and the hot side at junctions of element and electrode. at Imax, Qc=0
Qcmax : Maximum heat pumped at the cold side --- Heat pumped at Imax, ΔT=0
Thj : Hot junction temperature ------ Temperature at element/electrode junction at the hot side

The performance of the module varies due to temperature dependence of thermodynamic behavior and of performance of thermoelement. From this reason performance as Qc and ΔT improve with raising Thj temperature from 27℃ to 70℃.
Fig. 4 is a normalized performance diagram of a single-stage module, in which relationships of Qc-V-ΔT are normalized by each maximum value using the current as the parameter. When Qcmax, ΔTmax, Vmax and Imax in Table 1 are given, performance diagrams of respective models can be obtained. Fig. 5 shows KSM-06127A(Thj=50℃).

Selection of Appropriate Module

Usually, it is necessary to prevent current value I from exceeding 70% of Imax. Therefore, a module should be selected to satisfy the condition in Fig.4 in which the heat load Qc does not exceed the Qc/Qcmax decided by I/Imax=0.7 and ΔT/ΔTmax. The Qcmax to satisfy this condition can be found by using I/Imax=0.7(red line in Fig. 4).

$$Qcmax > \frac{0.94\,\Delta Tmax \cdot Qc}{0.91\,(0.94\,\Delta Tmax - \Delta T)}$$

Table2(page6) shows ΔTmax=73℃ at Thj=50℃, and giving Qc=12W, ΔT=53℃

$$Qcmax > \frac{0.94 \times 73 \times 12}{0.91\,(0.94 \times 73 - 53)} = 57.9\,(W)$$

You can choose KSM-06127A with Qc max of 61W from Table 2(page6). (note: Plural modules can be used from design restrictions.)

Determination of Operating Parameters

In order to determine the current and voltage in operation, you can use Fig. 5.
And from the current and voltage you get the power consumption and heat generation at the hot side. The procedure is as follows.
Step1 : Current(I) ---- From intersection (a) of Qc=12 and ΔT=53℃ you can find necessary I=4.2A.
Step2 : Voltage(V) ---- From intersection (b) of ΔT=53℃ and the V vs ΔT line of 4.2A, you can obtain necessary voltage of V=12.2V to operate.
Step3 : Hot side Heat Generation(Qh) :
Qh corresponds to a sum of Qc and power consumption in a module. Therefore, heat generation Qh=Qc+P=12+4.2×12.2=63(W)
Please note that it is necessary to dissipate this heat by adopting an appropriate heatsink in order to maintain the hot side temperature(Thj) at 50℃.

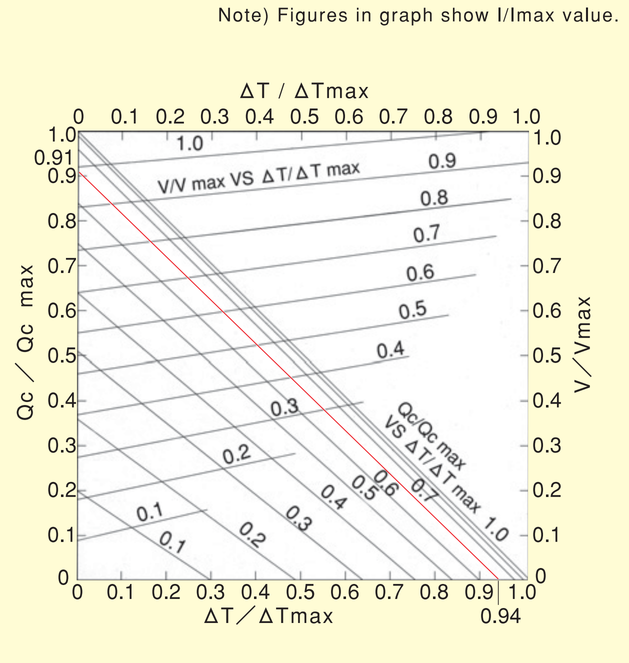


Fig.4 Normalized Performance Diagram

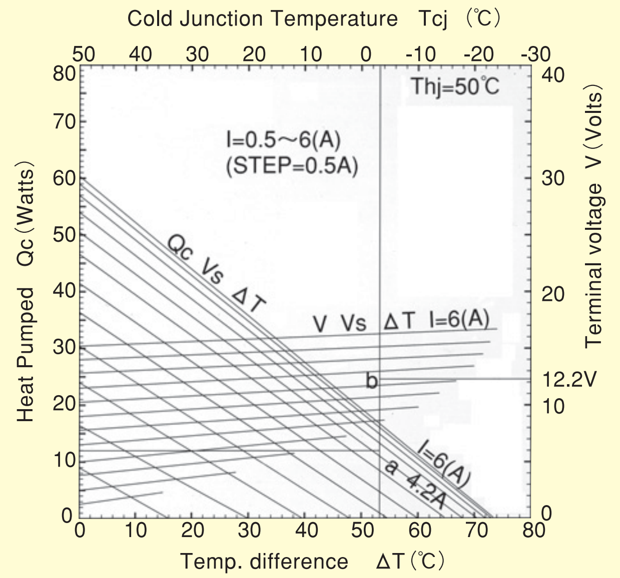


Fig.5 Performance Diagram of KSM-06127A

■Terminal Resistance and Temperature Distribution

When an object is cooled by a thermo-module, temperature distribution will be shown as in Fig. 6. At the cold side, between the cooled object and the cold junction, there are such thermal resistances as greased or bonded interface plus ceramics. Therefore, the cold junction temperature should be set at lower than that of the cooled object.
At the hot side, there are similar thermal resistances between the heatsink and the hot junction, so the hot junction temperature is higher than the heatsink. If a comparison is made between junction and such heat dissipating media as air or water, the temperature difference would be much larger. Depending on the area and cooling method (natural air, forced air, water) of the heatsink, thermal resistance greatly varies. Furthermore, thermal resistance also greatly depends on flow rate of the media.
For further information, please contact our technical department.

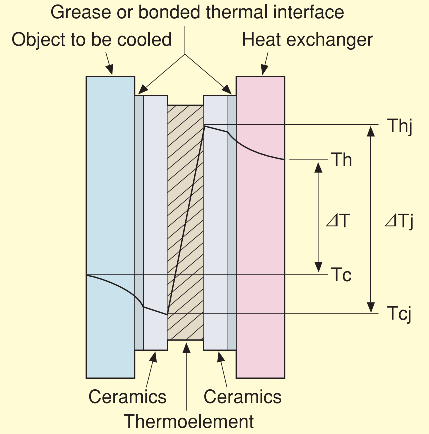


Fig.6 Temperature Distribution in an Operation

■Coefficient of Performance(COP)

The COP of the thermo-module significantly changes by temperature difference ΔT and by input current I. Fig. 7 shows an example of 71 couple module having Imax of 4A.(The cooling-mode COP is written as ϕ = Qc/IV.)
The figure indicates that the larger temperature difference you wish to obtain, the smaller COP you will get, resulting in less efficiency of the system. At a specific ΔT, there is an optimum current which maximizes the COP indicated by ϕ max line, however 50 to 70% of Imax is commonly adopted for total economy.

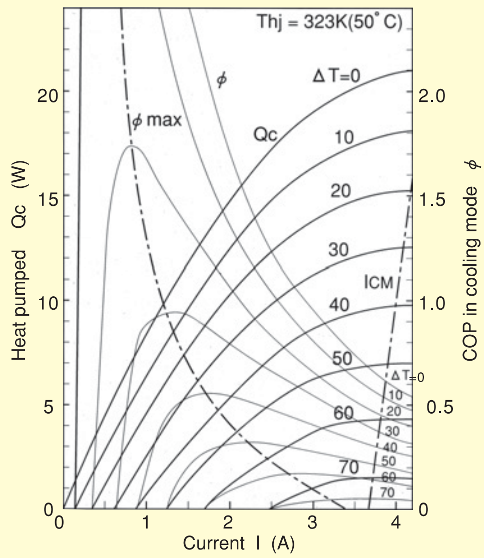


Fig.7 Qc-I-COP with the Parameter of ΔT

Caution in Use

- ● Never fail to confirm the polarity. In the standard arrangement, the right lead is the plus when you look down a module from the opposite face to the lead side face.
- ● DC current should be used and ripple content of 10 % or less is recommended.
- ● Be sure to attach a heatsink to the hot side when you input current. The solder would melt with no heatsink. The pressure contact with grease is properly done by 0.2˜0.5Mpa. Use heat isolation technique when you use metal screws to attach a heatsink.
- ● Continuous-use temperature should be 80℃ or less and do not exceed 160℃ even in a short time.
- ● Avoid a mechanical shock in handling a module. Do not machine a module.
- ● A module should be sealed with epoxy or something when used in an atmosphere below dew point.
- ● When you anticipate a thermal cycling, please consult our technical department.

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