

THERMOELECTRIC PRODUCTS CATALOGUE



CRYSTAL LTD.

2011

THE COMPANY

Crystal Ltd. was founded in 1990 by a group of specialists of the Moscow Steel and Alloys Institute (Moscow Technical University) aimed at establishing of the mass production technology of high quality TE materials (pellets) by modified Bridgeman method and thermoelectric modules.

- 1992: First thermoelectric elements production line
- 1993: Elements with nickel-based vacuum coatings
- 1997: Patent with Panasonic Corp. for thermoelectric elements mass production technology
- 2001: First thermoelectric modules production line
- 2004: Thermoelectric modules mass production factory
- 2007: R&D works on power generating materials based on BiTe solid solutions
- 2008: First power generating material (elements) and modules

COMPANY STRUCTURE

- 1) Head office in Korolev (Moscow region)
- 2) Mass production factory (Bogoroditsk, Tula region, 250 km from Moscow)
- 3) R&D facilities and laboratories (Moscow)



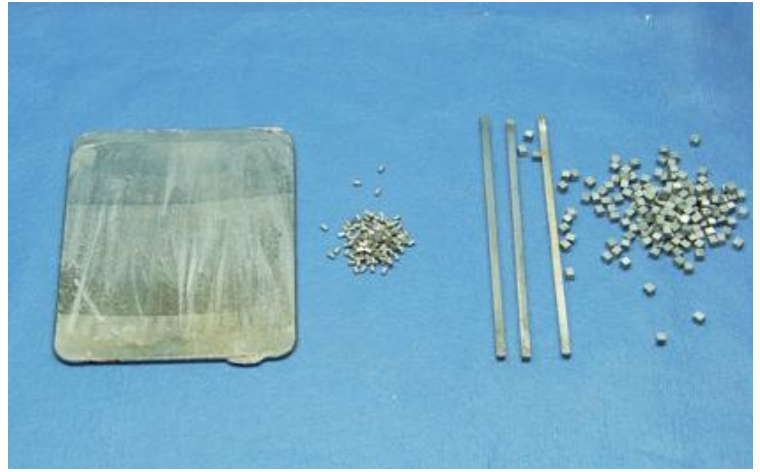
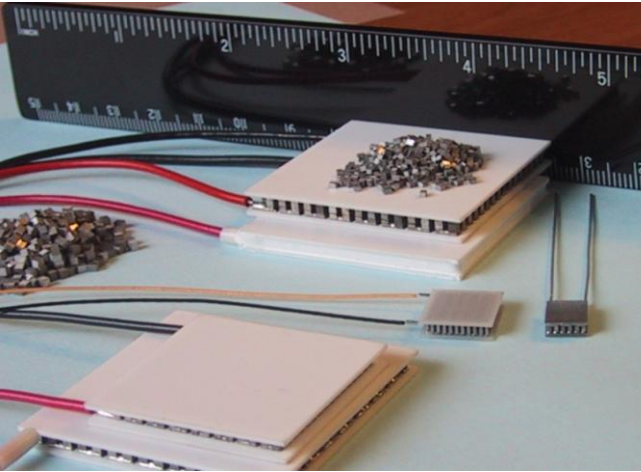
MISSION:

INTELLIGENT COOLING: YOUR VEHICLE, YOUR HOME, YOUR ENVIRONMENT

GOALS:

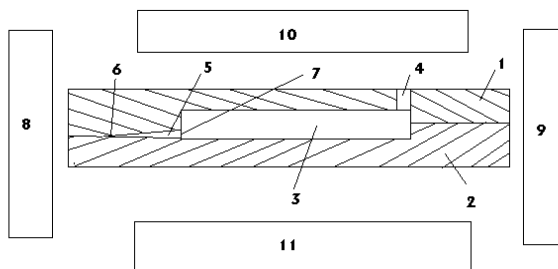
- ✓ **DEVELOPMENT, MANUFACTURE AND SALES OF STANDARD AND CUSTOMIZED THERMOELECTRIC PRODUCTS FOR HIGH PERFORMANCE APPLICATIONS.**
- ✓ **LEADING POSITIONS IN KEY MARKET SEGMENTS:**
 - LABORATORY & MEDICAL EQUIPMENT
 - TELECOMMUNICATIONS
 - AUTOMOTIVE APPLICATIONS
 - MILITARY APPLICATIONS
- ✓ **ORIENTATION AT LEADING WORLD MARKETS/CUSTOMERS THROUGH DIRECT SALES AND REPRESENTATIVES NETWORK**

THE PRODUCTS



Crystal Ltd. offers at the market a wide range of thermoelectric elements (based on Bi_2Te_3 solid solutions) and modules both for cooling and power generation. An original patented technology of thermoelectric material crystallization from a liquid melt in a flat cavity provides thermoelectric elements (TE) with a crystalline structure oriented strictly along direction of current providing a unique combination of thermoelectric and mechanical properties. The special methods of barrier multilayered Nickel and Molybdenum coatings deposition in vacuum also provide outstanding lifetime and thermal stability of elements and modules.

THERMOELECTRIC MATERIAL GROWING METHOD



- | | |
|---------------------------|-------------------------------|
| 1. Upper die | 5. Elongated slit |
| 2. Lower die | 6. Distal end |
| 3. Flat cavity | 7. Aperture |
| 4. Filling opening | 8, 9, 10, 11 - Heaters |

THERMOELECTRIC ELEMENTS

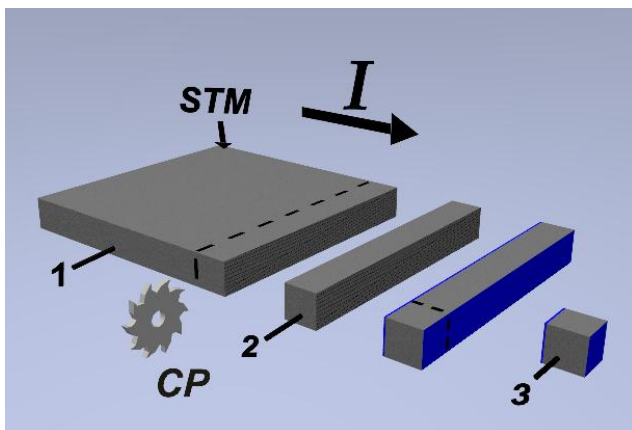
Since 1998 Crystal Ltd. has been producing thermoelectric elements of different cross-section and height. A unique technology allows growing the plates of thermoelectric material with defined width that forms one of the sizes of thermoelectric element (dice, pellet). It requires further only two cutting operations to form element's length and height. In result the elements have exact geometric dimensions.

An improved method of electro-erosive cutting technology is used to cut plates of thermoelectric material into elements with high accuracy of geometric dimensions and high quality of the surface after cutting.

Taking into consideration the above-mentioned features of thermoelectric elements, the several Ni-based coatings have been developed to use the elements for assembling the modules used in various applications. Crystal Ltd's own mass-production factory manufactures a wide range of thermoelectric modules in practically any necessary volumes.

All elements have the barrier antidiffusion coating fully compatible with RoHS requirements and modules assembling processes using lead-free solders.

THERMOELECTRIC ELEMENTS MANUFACTURING METHOD



STM: Semiconductor thermoelectric material

I: Direction of current

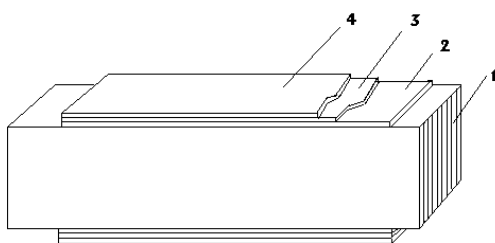
CP: Cutting plane

1: Plate of thermoelectric material (P- or N-type)

2: Bar ingot (P- or N-type)

3: Thermoelectric elements (P- or N-type)

COATING APPLICATION METHOD



Typical coating structure
(applied on elongated crystal - bar ingot):

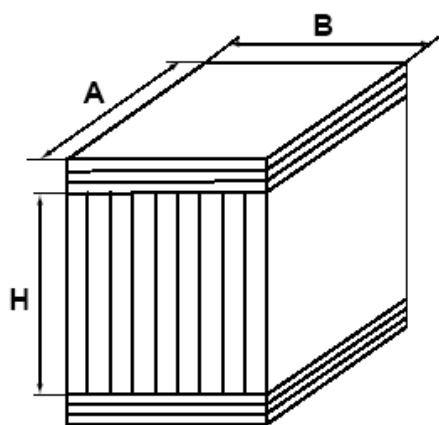
1. Semiconductor thermoelectric material
2. Antidiffusion layer
3. Commutation layer
4. Protective layer

THERMOELECTRIC ELEMENTS DESIGNATION SYSTEM

(USED BY CRYSTAL LTD.)

Example: TEE-1.0-1.6-3.00-950-26

TE	E	1.0	1.6	3.00	950	26
Thermoelectric Elements	Conductivity Type N-type (E) or P-type (H)	Elements cross-section, mm*	Height of elements, mm*	Figure of Merit**	Electric Conductivity***	Coating type



* Tolerance ± 0.02 mm

** Figure of Merit measured in chains of 6 couples of n+p elements connected in series, measured by Harman's Method, $\times 10^3 \text{ K}^{-1}$, in vacuum (control samples with dimensions A,B = 1.40 mm, H = 1.60 mm)

*** $\text{Ohm}^{-1}\text{cm}^{-1}$; standard tolerance: $\pm 5\%$; reduced tolerance of $\pm 3\%$ is available as additional option (MOQ 10 kg).

THERMOELECTRIC ELEMENTS COATING TYPES

TYPE “6M”

The elements with this coating are used to assemble the modules for traditional cooling applications with operation temperature up to 90⁰C. A 140⁰C, 180⁰C melting point solder is recommended for the assembling process.

The coating composition:

Nickel, Ni:	4.0 ± 1.0 micron
Tin-Bismuth, Sn-Bi (Bi < 1%):	4.0 ± 1.0 micron

TYPE “26”

The elements with this coating are used to assemble the modules for applications with operation temperature up to 110⁰C. The coating is applied by the magnetron for better uniformity and repeatability by orientation of metallization flow and applied metal layer thickness control. The antidiffusion Molybdenum sublayer protects the thermoelectric material from degradation of its electro-physical parameters. The preliminary etching of the working surface together with magnetron coating provides better density of metallization layer that also ensures repeatability of the coating adhesive strength. A 140⁰C, 180⁰C, 219⁰C, 232⁰C melting point solder is recommended for the assembling process.

The coating composition:

Molybdenum, Mo:	0.05 ± 0.02 micron
Nickel, Ni:	4.0 ± 1.0 micron
Tin-Bismuth, Sn-Bi (Bi < 1%):	4.0 ± 1.0 micron

TYPE “5B”

The elements with this coating are used to assemble the modules for applications with operation temperature up to 120⁰C and long-term “ON/OFF” operational mode. A 140⁰C, 180⁰C, 219⁰C, 232⁰C melting point solder is recommended for the assembling process.

The coating composition:

Molybdenum, Mo:	0.05 ± 0.02 micron
Nickel, Ni:	5.0 ± 1.0 micron
Tin-Bismuth, Sn-Bi (Bi < 1%):	7.0 ± 1.0 micron

TYPE “6B”

The elements with this coating are used to assemble the modules for cooling applications with operation temperature up to 150⁰C. A 140⁰C, 180⁰C, 219⁰C, 232⁰C melting point solders are recommended for the assembling process.

The coating composition:

Molybdenum, Mo:	0.05 ± 0.02 micron
Nickel, Ni:	8.0 ± 1.0 micron
Tin-Bismuth, Sn-Bi (Bi < 1%):	7.0 ± 1.0 micron

TYPICAL ELEMENTS SIZES

Length / Width, mm	Height, mm	Figure of merit, $10^3 K^{-1}$, in vacuum	Electric conductivity, $\text{Ohm}^{-1} \text{cm}^{-1}$, at 25°C
0.35	0.5 ÷ 2.4	2.97 ÷ 3.05	870 ÷ 1050
0.40			
0.45			
0.50			
0.52			
0.54			
0.61			
0.63			
0.65			
0.81			
0.85			
1.00			
1.20			
1.36			
1.40			
1.50			
1.78			
2.00			
2.10			
2.16			
2.30			
2.40			

The elements can be made accordingly to customer's special requirements:

- Other dimensions available within ranges:
 - Width – from 0.35 mm to 2.40 mm
 - Length – from 0.35 mm to 41 mm
 - Height – from 0.5 mm 5.00 mm
- Elements with heightened Figure of Merit (Z) = 3.05
- 100% appearance inspection
- Tolerance of every dimension ± 0.02 mm
- Elements of rectangular cross-section with A size not equal to B size
- Elements with crystalline structure oriented parallel to chosen couple of edges (AxH) or (BxH)
- Elements with variable width

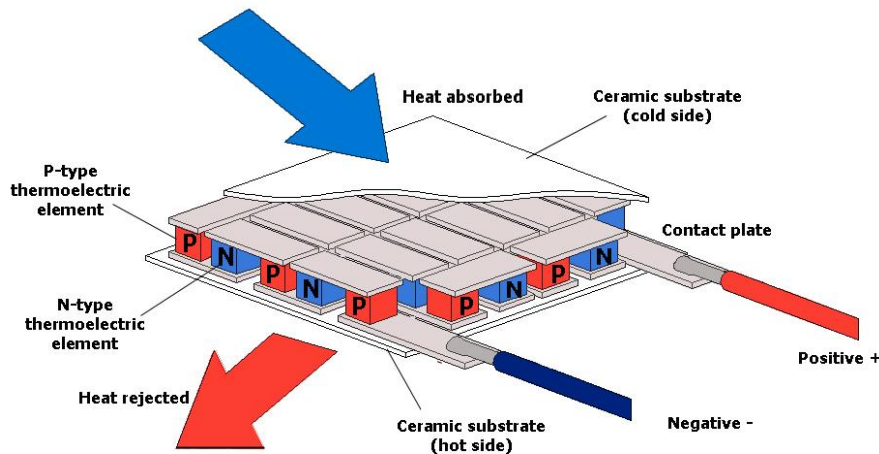
THERMOELECTRIC COOLING (PELTIER) MODULES

Thermoelectric module is a semiconductor-based solid-state device, which is used to convert electrical energy into temperature differential (Peltier effect) or, vice versa, thermal energy of temperature difference into electric power (Seebeck effect).

Thermoelectric module (TEM) consists of p-type and n-type semiconductor elements (dices, pellets), commutated by copper plates and sandwiched between two ceramic substrates. DC moves across the TEM, as a result, one side of TEM is cooled, the opposite side is heated.

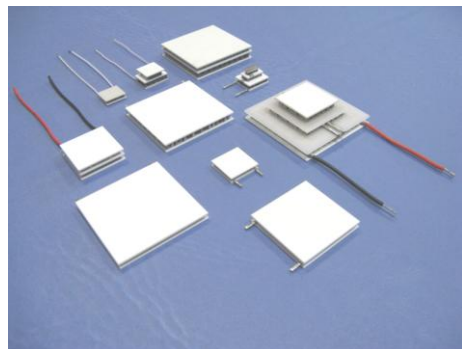
The number of thermoelectric elements may vary from several elements to hundreds. This allows designing a TEM with a desirable cooling power up to hundreds of Watts.

Thermoelectric modules have several features, which allow them to replace traditional compressor-based coolers in many applications: small size, solid-state design, precise temperature control, option of both heating and cooling in one device, reliability and low noise.



Crystal's family of modules for industrial and consumer applications provides the best functionality at the market:

- High performance;
- High reliability;
- Reasonable price;
- RoHS compatible, lead free;
- Silicon or Epoxy sealing;
- Any lead wires including UL – approved.



THERMOELECTRIC MODULES DESIGNATION SYSTEM

(USED BY CRYSTAL LTD.)

Example 1: S-127-14-16-L2-E

S	127	14	16	L2	E
Product series	Number of TE elements couples	Cross-section of elements.	Height of elements.	Thickness tolerance index	Sealing type

Example 2: S-017-12-10-RH-Tch1

S	017	12	10	RH	Tch1	-
Product series	Number of TE elements couples	Cross-section of elements, corresponds to 1.2 mm	Height of elements, corresponds to 1.0 mm	Round shape with hole	2-sides 117 ⁰ C solder tinned with height tolerance prior to tinning ± 0.15 mm	No sealing

S, SN, R, C, CH, D, DH, H – TYPICAL PRODUCT SERIES AVAILABLE

“S” - SERIES, “STANDARD”

High performance modules for traditional cooling applications (refrigeration, electronics, industrial, automotive)

- Maximum temperature for short time (to mount a module into unit): 130°C
- Recommended operation temperature: up to 120°C
- Max ΔT up to 75°C (at $T_{hot} = 25^\circ C$)
- Minimal cycling stability in ON-OFF power cycling mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Recommended operation current: 0.7 of I_{max}
- Recommended operation voltage: 0.8 of U_{max}

“R” - SERIES, “RELIANCE”

High performance for traditional cooling applications (refrigeration, electronics, industrial, automotive)

- Maximum temperature for short time (to mount a module into unit): 120°C
- Recommended operating temperature: up to 90°C
- Max ΔT : up to 75°C (at $T_{hot} = 25^\circ C$)
- Minimal cycling stability in ON-OFF power cycling mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Minimal cycling stability in 20/80 °C power cycling mode: over 25 000 cycles
- Mechanical strength
- Recommended operation current: 0.7 of I_{max}
- Recommended operation voltage: 0.8 of U_{max}

“C” - SERIES, “CYCLE”

High performance modules for long lifetime power cycling (cooling/heating).

- Maximum temperature for short time (to mount a module into unit): 130°C
- Recommended operating temperature: up to 120°C
- Recommended operation current: 0.7 of I_{\max} .
- Max ΔT : up to 75K (at $T_{\text{hot}} = 25^\circ\text{C}$)
- Minimal cycling stability in ON-OFF power cycling mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Minimal cycling stability in 20/80 °C power cycling mode: up to 25 000 cycles

“H” – SERIES, “HOT”

High performance modules for high temperature applications.

- Maximum temperature for short time (to mount a module into unit): 200 °C
- Recommended operation temperature: up to 150 °C
- Max ΔT up to 75K (at $T_{\text{hot}} = 25^\circ\text{C}$)
- Minimal cycling stability in ON-OFF power cycling mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Recommended operation current: 0.7 of I_{\max}

“D” - SERIES, HIGH POWER DENSITY MODULES (“HPDM”)

High performance modules for the applications where device (lasers, chip tests devices, etc.) generates a lot of heat that need to be dissipated continuously or for a short time.

- Recommended operating temperature: up to 120 °C
- Recommended operation current: 0.5 – 0.7 of I_{\max} .
- Minimal cycling stability in ON-OFF power mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Minimal cycling stability in 20/80 °C power cycling mode: up to 25 000 cycles

“SN” - SERIES, “STANDARD - 232”

High performance modules for traditional cooling applications (refrigeration, electronics, industrial, automotive)

- Maximum temperature to mount a module into unit: 200 °C
- Recommended operation temperature: up to 120 °C
- Max ΔT up to 75°C (at $T_{\text{hot}} = 25^\circ\text{C}$)
- Minimal cycling stability in ON-OFF power cycling mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Recommended operation current: 0.7 of I_{\max}
- Recommended operation voltage: 0.8 of U_{\max}
- Series is assembled on solder with melting point 232 °C

“CH” - SERIES, “CYCLE + HOT”

High performance modules for long lifetime power cycling (cooling/heating).

- Maximum operation temperature: 150°C
- Recommended operating temperature: up to 120°C
- Recommended operation current: 0.7 of I_{\max} .

- Max ΔT : up to 75K (at $T_{hot} = 25\text{ }^{\circ}\text{C}$)
- Minimal cycling stability in ON-OFF power cycling mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Minimal cycling stability in 20/80 $^{\circ}\text{C}$ power cycling mode: up to 25 000 cycles

“DH” - SERIES, HIGH POWER DENSITY MODULES (“HPDM”) + HOT

High performance modules for the applications where device (lasers, chip tests devices, etc.) generates a lot of heat that need to be dissipated continuously or for a short time.

- Maximum temperature for short time (to mount a module into unit): 200 $^{\circ}\text{C}$
- Maximum operation temperature): 150 $^{\circ}\text{C}$
- Recommended operation current: 0.5 – 0.7 of I_{max} .
- Minimal cycling stability in ON-OFF power cycling mode: over 60 000 cycles (cycle time is 120 seconds or more)
- Minimal cycling stability in 20/80 $^{\circ}\text{C}$ power cycling mode: over 25 000 cycles

OPTIONS FOR SURFACES FINISH

L1 – height tolerance ± 0.01 mm

L2 – height tolerance ± 0.02 mm

R – round shape of the module

H – module has a circular hole in the ceramics

Mch – both sides have metallization (height tolerance ± 0.15)

Mc – only cold side has metallization (height tolerance ± 0.15)

Mh – only hot side has metallization (height tolerance ± 0.15)

TchX – both sides have tinning, height tolerance before tinning ± 0.15

TcX – only cold side has tinning, height tolerance before tinning ± 0.15

ThX – only hot side has tinning, height tolerance before tinning ± 0.15

X – type of solder used for tinning: 1 – solder with melting temperature 117 $^{\circ}\text{C}$,
2 – solder with melting temperature 138 $^{\circ}\text{C}$.

No code – module is not lapped without metallization or tinning

SEALING TYPE

S – silicon sealing;

E – epoxy sealing;

Absence of sealing index means modules without sealing.

STANDARD WIRE INSULATION

UL 1569 PVC 105 $^{\circ}\text{C}$ for S, R, C, D series.

UL 1213 PTFE or 1180 PTFE 200 $^{\circ}\text{C}$ for SN, H, CH, DH series.

NOTE! Max ΔT is reduced by 2-3 $^{\circ}\text{C}$ for silicone and by 1-2 $^{\circ}\text{C}$ for epoxy sealing versions.

**THE MODULES CAN BE ASSEMBLED IN KITS WITH SERIES OR PARALLEL CONNECTION
OR INSTALLED IN A DEVICE FOLLOWING CUSTOMER’S DESIGN & CONSTRUCTION
DOCUMENTATION**

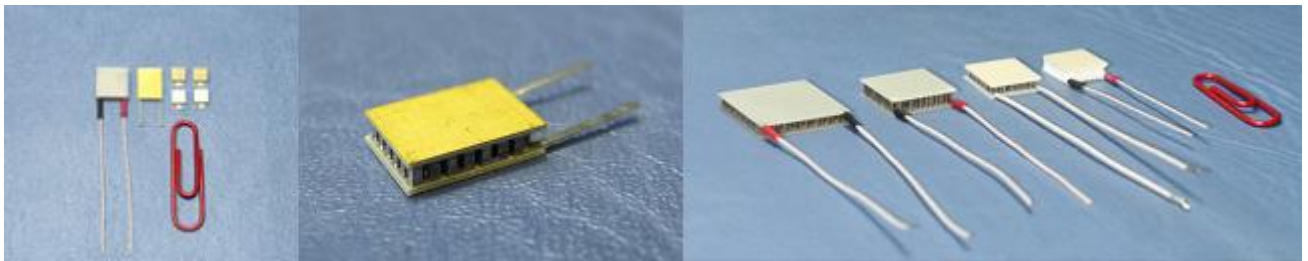
STANDARD THERMOELECTRIC MODULES

Other available series					Catalog Number in "S" - Series, "Standard"	$T_{hot} = 25^{\circ}\text{C}$				R_{AC} , at 25 $^{\circ}\text{C}$ Ohm	Dimensions, mm		
						I_{max} , A	U_{max} , V	Q_{max} , Wt	ΔT_{max} , C		A/A1	B	H
SN	R			H	S-007-10-08	5.7	0.9	3.1	72.5	0.12	8	8	3.1
SN	R			H	S-017-10-08		2.2	7.7		0.29	10	10	
SN	R	C	CH	H	S-031-10-08		3.9	13.9		0.52	15	15	
SN	R	C	CH	H	S-071-10-08		9	32		1.20	20	20	
SN	R	C	CH	H	S-127-10-08		16.2	57.6		2.13	30	30	
SN	R	C	CH	H	S-241-10-08		30.7	109.1		4.05	40	40	
SN	R			H	S-007-10-13	3.4	0.9	2.1	74.5	0.20	8	8	3.6
SN	R			H	S-017-10-13		2.2	5.1		0.47	10	10	
SN	R	C	CH	H	S-031-10-13		3.8	9.3		0.87	15	15	
SN	R	C	CH	H	S-063-10-13		8.0	18.8		1.76	30 (15)	15 (30)	
SN	R	C	CH	H	S-071-10-13		9.0	21.2		1.98	20	20	
SN	R	C	CH	H	S-127-10-13		16.2	37.9		3.55	30	30	
SN	R	C	CH	H	S-131-10-13		16.7	39.1		3.66	40	23	
SN	R	C	CH	H	S-241-10-13		30.7	71.8		6.73	40	40	
SN	R	C	CH	H	S-287-10-13		36.6	85.6		8.01	40	40	
SN	R			H	S-007-10-15	3	0.9	1.8	74.5	0.23	8	8	3.8
SN	R			H	S-017-10-15		2.2	4.4		0.55	10	10	
SN	R	C	CH	H	S-031-10-15		3.9	8.1		1.00	15	15	
SN	R	C	CH	H	S-063-10-15		8.0	17		2.04	30	15	
SN	R	C	CH	H	S-071-10-15		9.0	18.6		2.29	20	20	
SN	R	C	CH	H	S-127-10-15		16.2	33.2		4.09	30	30	
SN	R	C	CH	H	S-241-10-15		30.7	63		7.77	40	40	
SN	R	C	CH	H	S-287-10-15		36.6	75		9.25	40	40	
SN	R	C	CH	H	S-031-10-20	2.2	3.9	5.5	75	1.33	15	15	4.3
SN	R	C	CH	H	S-127-10-20		16.2	22.5		5.46	30	30	
SN	R			H	S-007-10-25	1.8	0.9	1.1	75.5	0.38	8	8	4.8
SN	R			H	S-017-10-25		2.2	2.6		0.92	10	10	
SN	R	C	CH	H	S-031-10-25		3.9	4.8		1.68	15	15	
SN	R	C	CH	H	S-063-10-25		8,0	8,9		3,41	30 (15)	15 (30)	
SN	R	C	CH	H	S-071-10-25		9.0	11		3.84	20	20	
SN	R	C	CH	H	S-127-10-25		16.2	19.7		6.88	30	30	
SN	R	C	CH	H	S-241-10-25		30.7	37.4		13.04	40	40	
SN	R	C	CH	H	S-161-12-08	7,8	20.5	99.8	72	1.98	40	40	3.3
SN	R	C	CH	H	S-161-12-10	6.6	20.5	84.2	72.5	2.49	40	40	3.3
SN	R	C	CH	H	S-161-12-15	4.0	20.5	54.6	74.5	3.88	40	40	3.9
SN	R	C	CH	H	S-161-12-13	4.5	20.5	62.4	74.5	3.42	40	40	3.7
SN	R	C	CH	H	S-032-14-045	21.4	4.1	53.3	66	0.15	20	20	3.3
SN	R	C	CH	H	S-199-14-08	11.3	25.3	178.3	71	1.69	40 (40/44)	40	3.5
SN	R			H	S-007-14-11	7.8	0.9	4.5	72.5	0.09	10	10	3.8
SN	R	C	CH	H	S-017-14-11		2.2	11		0.21	15	15	
SN	R	C	CH	H	S-031-14-11		3.9	20		0.38	20	20	
SN	R	C	CH	H	S-071-14-11		9.0	45.9		0.87	30	30	
SN	R	C	CH	H	S-127-14-11		16.2	82.1		1.55	40	40	
SN	R	C	CH	H	S-199-14-11		25.3	128.6		2.43	40	40	
SN	R	C	CH	H	S-241-14-11		30.7	155.8		2.94	55	55	
SN	R	C	CH	H	S-007-14-13	6.8	16.2	69	74.5	1.80	10	10	3.9
SN	R	C	CH	H	S-007-14-15	5.5	0.9	3.3		0.12	10	10	
SN	R	C	CH	H	S-017-14-15		2.2	7.9		0.30	15	15	
SN	R	C	CH	H	S-031-14-15		3.9	14.5		0.54	20	20	
SN	R	C	CH	H	S-071-14-15		9.0	33.2		1.24	30	30	

Other available series					Catalog Number in "S" - Series, "Standard"	T _{hot} = 25°C				R _{AC} , at 25°C Ohm	Dimensions, mm		
						I _{max} , A	U _{max} , V	Q _{max} , Wt	ΔT _{max} , C		A/A1	B	H
SN	R	C	CH	H	S-127-14-15	5.5	16.2	59.4	74.5	2.22	40	40	3.9
SN	R	C	CH	H	S-059-14-15	6.0	7.6	27.9		0.93	29.5	24.5	
SN	R	C	CH	H	S-161-14-15	6.0	20.5	76.7		2.57	40	40	
SN	R	C	CH	H	S-199-14-15	5.5	25.3	93.1		3.49	40	40	
SN	R	C	CH	H	S-241-14-15		30.7	112.7	4.23	55	55		
SN	R	C	CH	H	S-059-14-15	6.0	7.6	27.9	74	0.93	29.5	24.5	4.8
SN	R			H	S-007-14-25	3.5	0.9	2.1	75.5	0.19	10	10	
SN	R	C	CH	H	S-017-14-25		2.1	5.2		0.46	15	15	
SN	R	C	CH	H	S-031-14-25		3.9	9.4		0.84	20	20	
SN	R	C	CH	H	S-071-14-25		9.0	21.6		1.92	30	30	
SN	R	C	CH	H	S-127-14-25		16.2	38.6		3.43	40	40	
SN	R	C	CH	H	S-241-14-25		30.7	73.2		6.51	55	55	
SN	R	C	CH	H	S-007-20-15	12.1	0.9	7.1	74.5	0.06	15	15	4.6
SN	R	C	CH	H	S-017-20-15		2.2	17.2		0.13	20	20	
SN	R	C	CH	H	S-031-20-15		3.9	31.4		0.25	30	30	
SN	R	C	CH	H	S-071-20-15		9.0	71.9		0.56	40	40	
SN	R	C	CH	H	S-127-20-15		16.2	128.7		1.00	55	55	
SN	R	C	CH	H	S-031-20-25	7.2	3.9	18.8	75.5	0.41	30	30	5.6
SN	R	C	CH	H	S-071-20-25		9.0	44		0.94	40	40	
SN	R	C	CH	H	S-127-20-25		16.2	78.7		1.68	55 (62)	55 (62)	

I_{max}, U_{max}, Q_{max} tolerance: ± 5%, R_{AC} standard tolerance: ± 10%; ± 5% is possible by request

MINIATURE MODULES AVAILABLE IN "S" AND "H" - SERIES, "STANDARD" AND "HOT"



Other available series	Catalog Number	Thot= 25°C				RAC at 25°C, Ohm	Dimensions, mm		
		I _{max} , A	U _{max} , V	Q _{max} , Wt	dT _{max} , C		A/A1	B	H
H	S-008-03-09	0.44	1	0.3	71.5	1.76	2.5/3.5	2.5	2.05
H	S-018-03-09		2.3	0.6		3.95	3.5	3.5	
H	S-032-03-09		4.1	1.1		7.02	5	5	
H	S-012-04-07	1.1	1.5	1.0	71	1.11	6.4	2.4	1.5
H	S-007-05-15	0.8	0.9	0.4	74.5	0.88	4	4	3
H	S-011-05-15		1.4	0.7		1.38	4	6	
H	S-017-05-15		2.2	1		2.14	6	6	
H	S-031-05-15		3.9	2		3.91	8	8	
H	S-065-05-15		8.3	4.2		8.20	11	12	
H	S-071-05-15		8.5	4.1		8.30	12	12	
H	S-127-05-15		15.5	7.4		14.90	15	15	
H	S-241-05-15		29.5	14.1		28.10	21	21	
H	S-007-05-20	0.6	0.9	0.3	75.5	1.40	4	4	3.5
H	S-011-05-20		1.4	0.5		1.70	6	4	
H	S-017-05-20		2.1	0.8		2.70	6	6	
H	S-031-05-20		3.9	1.5		5.22	8	8	
H	S-071-05-20		8.5	3.1		11.2	12	12	
H	S-127-05-20		15.5	5.6		20.00	15.5	15	

Other available series	Catalog Number	Thot= 25°C				RAC at 25 °C, Ohm	Dimensions, mm			
		I _{max} , A	U _{max} , V	Q _{max} , Wt	dT _{max} , C		A/A1	B	H	
H	S-241-05-20	0.6	29.5	10.7	75.5	38.00	21	21	3.5	
H	S-018-055-09	1.53	2.3	2.2	71	1.15	6/7.6	6	2	
H	S-007-06-11	1.4	0.9	0.8	72.5	0.46	4	4	2.7	
H	S-017-06-11		2.2	2		1.14	6	6		
H	S-018-06-11		2.2	2.1		1.25	6	6		
H	S-023-06-11		2.9	2.6		1.53	8.2	6		6
H	S-029-06-11		3.7	3.3		1.93	10.2	6		6
H	S-031-06-11		3.9	3.7		1.99	8	8		8
H	S-068-06-11		8.7	7.8		4.53	13.2	13.2		13.2
H	S-032-06-18		0.9	3.9		2.2	74	3.60		13.9
H	S-023-065-1	2.0	2.9	3.7	72.5	1.10	6.6	10.6	1.7	
H	S-007-07-10	2.2	0.9	1.3		0.30	6	6	2.5	
H	S-011-07-10	2.2	1.4	2.0	72.5	0.47	6	8	2.5	
H	S-017-07-10		2.2	3.0		0.73	8	8		
H	S-031-07-10		3.9	5.5		1.33	10	10		
H	S-065-07-10		8.3	11.5		2.79	14	15		15
H	S-071-07-10		8.8	11.7		3.40	15	15		15
H	S-127-07-10		15.7	20.9		6.10	20	20		20
H	S-241-07-10		29.8	39.7		11.50	30	30		30
H	S-007-07-15		1.5	0.9		0.9	74.5	0.45		6
H	S-011-07-15	1.4		1.4	0.71	6		8		
H	S-017-07-15	2.2		2.2	1.10	8		8		
H	S-031-07-15	3.8		3.6	2.20	10		10	10	
H	S-071-07-15	8.8		8.2	5.10	15		15	15	
H	S-127-07-15	15.7		14.6	9.20	20		20	20	
H	S-241-07-15	29.8		27.7	15.30	30		30	30	
H	S-007-07-20	1.2		0.9	0.6	74		0.60	6	6
H	S-011-07-20		1.4	1.0	1.00		8	6		
H	S-017-07-20		2.1	1.5	1.60		8	8		
H	S-031-07-20		3.8	2.8	2.80		10	10	10	
H	S-065-07-20		8.1	6.0	5.75		14	15	15	
H	S-071-07-20		8.8	6.3	6.20		15	15	15	
H	S-127-07-20		15.7	11.3	11.00		20	20	20	
H	S-241-07-20		29.8	21.4	20.90		30	30	30	
H	S-007-07-25	1.0	0.9	0.5	75	0.80	6	6	3.9	
H	S-011-07-25		1.4	0.8		1.30	8	6		
H	S-017-07-25		2.1	1.2		2.00	8	8		
H	S-031-07-25		3.8	2.2		3.70	10	10		10
H	S-071-07-25		8.8	5.1		8.50	15	15		15
H	S-127-07-25		15.7	9.1		15.20	20	20		20
H	S-241-07-25		29.8	17.3		28.80	30	30		30
H	S-241-08-10		3.0	30.7		57.2	72.5	7.72		30
H	S-241-08-13	2.3	30.7	44	74.5	10.04	30	30	3.6	
H	S-007-08-15	1.9	0.9	1.2	74.5	0.35	6	6	3.8	
H	S-017-08-15		2.2	2.8		0.84	9	9		
H	S-031-08-15		3.9	5.1		1.53	13	13		13
H	S-063-08-15		8.0	10.4		3.10	25	12		12
H	S-071-08-15		9.0	11.7		3.50	18	18		18
H	S-127-08-15		16.2	20.9		6.25	25	25		25
H	S-127-08-25	1.2	16.2	12.6	75.5	10.51	25	25	4.8	

I_{max}, U_{max}, Q_{max} tolerance: ± 5%, R_{AC} standard tolerance: ± 10%; ± 5% is possible by request

Miniature modules < 10x10 mm have height tolerance ±0,15 mm

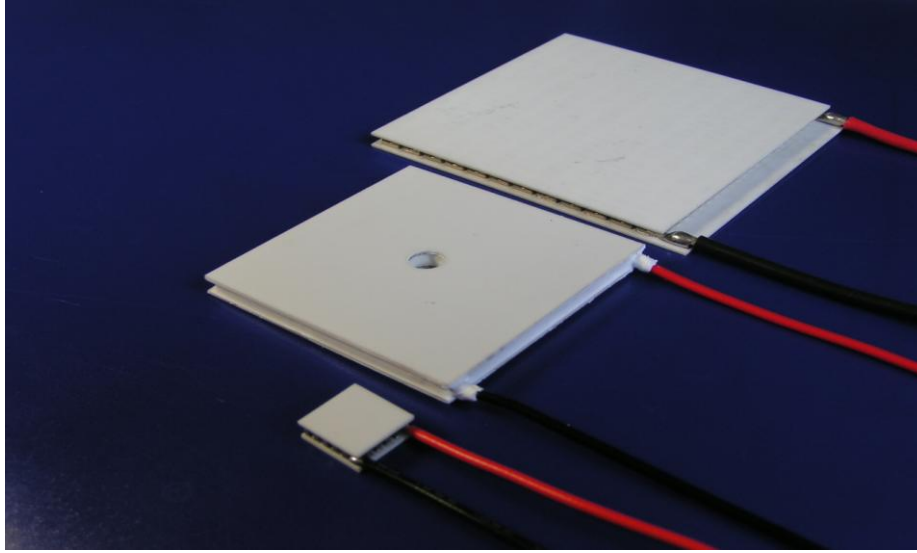
Most of the mini modules are not being polished after assembling, tolerance is ± 0.15 mm

Mini modules with dimensions of elements < 0.81x0.81 are assembled only in S series.

In mini modules output wires can be single core wires with no insulation.

Cross-section and length of output wires can be customized.

“D” – SERIES: HIGH POWER DENSITY MODULES (HPDM)



Other available series	Catalog Number	$T_{hot} = 25^{\circ}\text{C}$				R_{AC} at 25°C , Ohm	Dimensions, mm			
		I_{max} , A	U_{max} , V	Q_{max} , Wt	dT_{max} , C		A	A1	B	H
DH	D-128-10-05	8.9	16.3	89.8	68	1.39	30	34	30	2.8
DH	D-242-10-05		30.8	169.7		2.63	40	44	40	
DH	D-288-10-05		36.7	201.9		3.13	40	44	40	
DH	D-200-10-06	7.6	25.3	120.7	71	2.51	40	44	40	2.54
DH	D-288-10-08	5.7	36.7	129.2	71	4.90	40	44	40	3.1
DH	D-127-14-04	23.2	16.3	231	68	0.57	40	44	40	
DH	D-128-14-06	14.9	16.3	152.3	68	0.82	40	44	40	
DH	D-200-14-06		25.5	236.8		1.29	40	44	40	
DH	D-242-14-06		30.8	285.9		1.56	52	56	52	
DH	D-288-14-06		36.7	340.3		1.86	52	56	52	
DH	D-200-14-11	7.8	25.5	125.4	68	2.43	40	44	40	3.3
DH	D-288-14-11		36.7	180.0		3.56	52	56	52	
DH	D-128-20-08	22.4	16.3	227	71	0.55	55	59	55	4.0

I_{max} , U_{max} , Q_{max} tolerance: $\pm 5\%$, R_{AC} standard tolerance: $\pm 10\%$; $\pm 5\%$ is possible by request

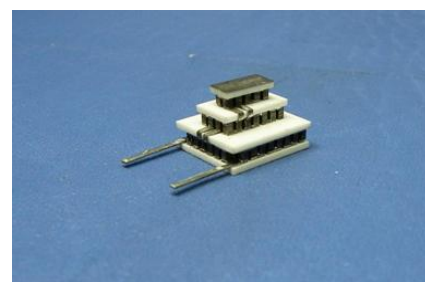
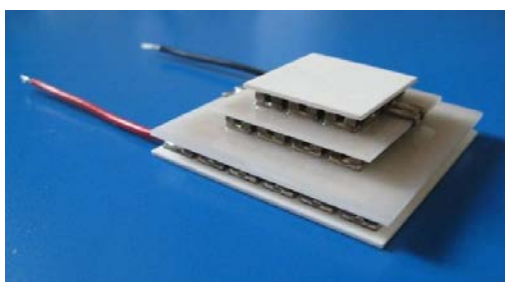
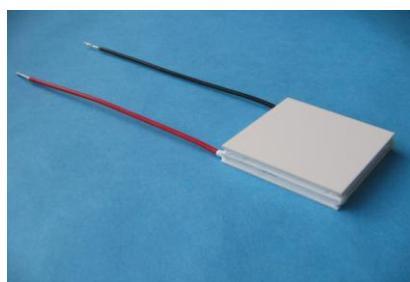
CENTER HOLE MODULES

Other available series					Catalog Number	$T_{hot} = 25^{\circ}\text{C}$				R_{AC} at 25°C , Ohm	Dimensions, mm			
						I_{max} , A	U_{max} , V	Q_{max} , W	dT_{max} , C		A	B	d	H
SN	R	C	H	S-038-10-13-RH	3.4	4.8	11.3	74.5	1.06	24	24	10	3.6	
SN	R	C	H	S-119-10-13-H		15.2	35.5		3.32	30	30	4.7		
SN	R	C	H	S-125-14-11-H	7.8	15.9	80.8	72.5	1.53	40	40	4.7	3.8	
SN	R	C	H	S-032-14-15-RH	5.5	4.1	15	74.5	0.56	55*	44	27	3.9	
SN	R	C	H	S-125-14-15-H		15.9	58.5		2.19	40	40	4.7		
SN	R	C	H	S-014-14-25-RH	3.5	1.8	4.3	75.5	0.39	26	26	14	4.7	
SN	R	C	H	S-125-14-25-H	3.9	15.5	38.0	75.5	3.31	40	40	4.7	4.8	

* Outer diameter on hot side = 55 mm. Outer diameter on cold side = 44 mm

I_{max} , U_{max} , Q_{max} tolerance: $\pm 5\%$, R_{AC} standard tolerance: $\pm 10\%$; $\pm 5\%$ is possible by request

MULTISTAGE MODULES



High performance modules for applications requiring high cooling capacity at high temperature difference. Because of design features these modules are used in cooling mode only.

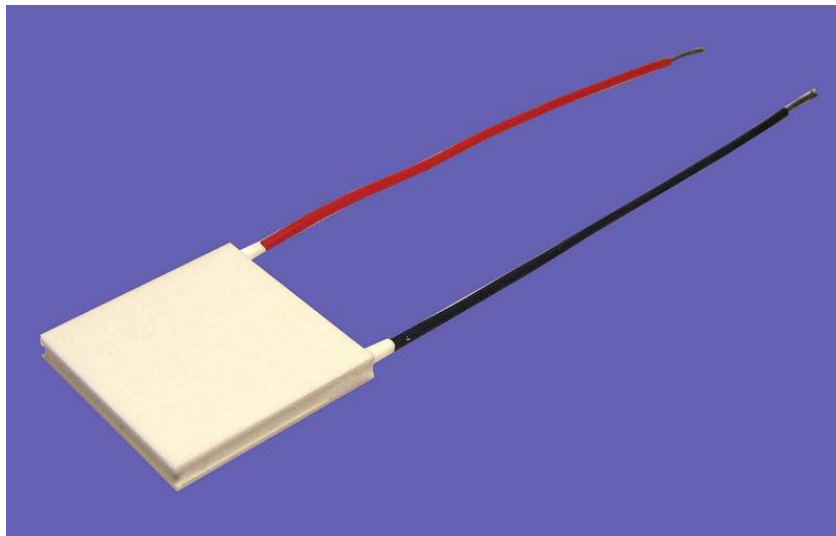
- Recommended operation temperature: up to 90°C
- Recommended operation current: 0.7 of I_{max}
- Wires: UL-approved, PVC insulated

Catalog Number	$T_{hot} = 25^{\circ}C$				R_{AC} at 25 °C, Ohm	Dimensions, mm				
	I_{max} , A	U_{max} , V	Q_{max} , W	dT_{max} , C		A1	B1	A2	B2	H
2-010-06-11	1.1	0.9	0.35	92	0.66	3.9	3.9	3.2	3.2	4.2
2-024-06-11	1.1	2.2	0.81	92	1.58	6.1	6.1	4.1	4.1	4.6
2-041-04-11	0.7	3.9	0.68	89	5.00	12.0	12.0	5.0	5.0	4.0
2-045-10-20	2.2	4.2	1.95	90	1.90	15.2	15.2	10.9	10.9	8.0
2-045-10-30	1.2	4.0	1.3	90	2.90	10.9	10.9	15.2	15.2	10.0
2-046-1420-1630	4.3	3.8	5.6	85	0.76	20.0	20.0	20.0	20.0	8.8
2-049-10-15	2.1	3.8	3.4	85	1.58	15.0	15.0	11.5	11.5	6.6
2-158-10-15	3.0	16.2	7.5	95	5.00	30	30	15	15	7.0
2-049-14-15	4.0	3.8	6.6	85	0.85	20.0	20.0	15.0	15.0	7.2
2-051-1420-1118	6.9	4.6	10.2	85	0.56	30.0	30.0	15.0	15.0	7.3
2-052-20-22	5.2	3.6	9.5	80	0.60	30.0	30.0	30.0	30.0	10.7
2-068-14-15	5.0	6.2	8.7	92	1.20	23.6	23.6	23.6	23.6	7.9
2-089-14-15	5.2	9.0	9.3	95	1.52	30.0	30.0	30.0	30.0	7.4
2-095-10-30	1.2	8.0	3.0	90	6.05	18.5	18.5	18.5	18.5	10.0
2-102-14-15	4.3	8.2	12.4	87	1.70	30.0	30.0	30.0	30.0	7.3
2-107-10-12	3.0	9.2	9.2	87	2.72	22.6	22.6	22.6	22.6	6.2
2-158-10-15	2.6	15.0	7.5	95	5.00	30.0	30.0	30.0	30.0	7.2
2-162-1420-1118	7.8	16.0	29.3	95	1.82	40.0	40.0	40.0	40.0	7.6
2-176-14-15	4.6	15.7	22.5	90	3.19	40.0	40.0	40.0	40.0	7.2
2-176-14-30	2.5	15.7	11.1	90	5.69	40.0	40.0	40.0	40.0	10.3
2-190-10-12	2.8	15.7	16.4	85	4.92	30.0	30.0	30.0	30.0	6.5
2-192-12-15	4.0	20.5	9.8	90	4.63	40	40	20	20	7.0
2-192-1420-1118	6.7	15.6	39.3	84	2.21	40.0	40.0	40.0	40.0	8.1
2-192-1420-1425	4.4	16.0	27.3	85	3.12	40.0	40.0	40.0	40.0	8.1
2-196-19-14	8.5	16.1	51.6	84	1.70	40.0	40.0	40.0	40.0	7.0
2-198-14-11	5.7	15.8	35.2	82	2.35	40.0	40.0	40.0	40.0	6.2
2-199-20-15	9.3	15.6	57.1	84	1.62	62.0	62.0	62.0	62.0	8.9
2-199-10-13	2.4	15.7	16.5	83	5.50	30.0	30.0	30.0	30.0	6.1
3-052-10-15	2.1	3.7	1.4	102	1.65	15.0	15.0	15.0	15.0	9.9
3-054-10-13	2.6	4.1	1.52	107	1.50	12.5	12.5	14.0	14.0	9.2
3-055-10-15	2.0	3.8	1.5	100	1.74	15.0	15.0	15.0	15.0	9.9
3-070-20-25	6.5	6.5	3.0	117	0.93	36.0	36.0	36.0	36.0	16.0
3-087-06-11	1.2	7.5	6.8	105	5.50	11.0	11.0	11.0	11.0	8.5

Catalog Number	$T_{hot} = 25^{\circ}\text{C}$				R_{AC} at 25°C , Ohm	Dimensions, mm				
	I_{max} , A	U_{max} , V	Q_{max} , W	dT_{max} , C		A1	B1	A2	B2	H
3-119-14-15	3.9	8.0	7.5	99	2.09	30.0	30.0	30.0	30.0	10.4
3-119-20-14	8.0	8.2	14.9	99	0.90	44.0	44.0	44.0	44.0	12.9
3-229-20-15	7.4	15.5	28.6	88	1.80	62.0	62.0	62.0	62.0	12.9
3-229-14-15	3.6	15.7	12.5	98	3.93	40.0	40.0	40.0	40.0	10.5
3-231-20-14	8.3	15.3	26.8	97	1.56	62.0	62.0	62.0	62.0	13.0
3-231-20-15	8.0	16.0	29.9	101	1.80	61.0	61.0	61.0	61.0	14.5
3-231-10-15	1.9	15.5	6.9	104	7.22	30.0	30.0	30.0	30.0	9.5
4-075-20-22	6.1	6.0	1.8	122	0.87	36.3	36.3	36.3	36.3	20.3
4-106-14-10	5.4	7.8	3.75	125	1.32	21.7	21.7	28.3	28.3	9.3
4-111-10-20	1.4	7.2	1.2	110	4.70	18.0	18.0	23.9	23.9	14.6
4-115-14-15	3.5	7.6	2.6	121	1.95	24.0	24.0	33.0	33.0	13.8
4-129-10-15	1.8	8.2	1.9	113	3.83	23.0	23.0	23.0	23.0	12.5
4-246-20-15	6.8	15.3	14.3	105	1.97	62.0	62.0	62.0	62.0	17.0
4-246-14-15	3.2	15.3	6.7	109	4.22	40.0	40.0	40.0	40.0	14.0
5-131-1420-1122	5.4	7.8	1.73	125	1.40	29.7	29.7	29.7	29.7	24.3
5-195-20-30	4.0	13.0	2.47	125	3.10	40.0	40.0	45.0	45.0	26.0
5-195-1420-2040	3.0	13.0	1.86	129	4.20	35.0	35.0	31.0	31.0	24.4
5-253-10-15	1.8	15.0	1.9	120	7.80	30.0	30.0	30.0	30.0	16.2
5-257-10-15	1.8	15.0	2.0	123	7.90	30.0	30.0	30.0	30.0	15.4
6-255-14-15	3.2	15.0	1.1	125	4.20	40.0	40.0	40.0	40.0	20.8

U_{max} , I_{max} , Q_{max} tolerance: $\pm 5\%$; R_{AC} standard tolerance: $\pm 10\%$; $\pm 5\%$ is possible by request

POWER GENERATING MODULE G-127-14-16-L-S



Characteristics	Value
Delta T	125 °C
Hot side temperature	175 °C
Generated power P load at $\Delta T = 125^{\circ}\text{C}$	3,6 W
Load voltage for matched load resistance at $\Delta T = 125^{\circ}\text{C}$	2,7 V
Sides dimension	40 x 40 mm
Height	3,9 mm
Module resistance at $T_{hot} = 150^{\circ}\text{C}$ and $T_{cold} = 50^{\circ}\text{C}$ ($\Delta T = 100^{\circ}\text{C}$), Ohm	$1.90 \pm 10\%$
Module dimensions (without wires), mm	$40 \times 40 \pm 0.3$
Life resource at $T_{hot} = 150^{\circ}\text{C}$ and $T_{cold} = 50^{\circ}\text{C}$ ($\Delta T = 100^{\circ}\text{C}$)	over 20000 hours
Product is compliant to RoHS requirements	

THERMOELECTRIC ASSEMBLIES

Thermoelectric assemblies (TEAs) are using Crystal's thermoelectric modules (TEM) as an active cooling component. The TEMs have been specially designed for conditions of work of TEAs and obtaining best COP and minimize power consumption. Thermoelectric assemblies are supplied in a wide range of cooling power and voltage. Custom configurations and moisture protection options are available, however, MOQ applies.

Thermoelectric assemblies are available in several series:

- Air-to-Air
- Direct-to-Air
- Liquid-to-Air
- Liquid-to-Liquid
- Direct-to-Liquid

Standard cooling powers are the following:

20 Watt
30 Watt
40 Watt
50 Watt
60 Watt
70 Watt
100 Watt
150 Watt
200 Watt
240 Watt



Features

- RoHS compliant
- Compact design
- Reliability
- Precise temperature control
- DC operation

Applications

- Medical diagnostics
- Analytical instrumentation
- Laser systems
- Industrial applications
- Food and beverage
- Telecom

The TEA consists of 5 parts, which are thermoelectric cooling module (including sealing and heat insulating materials), cold end radiator, hot end radiator, cold end fan, hot end fan. When power is supplied to the TEA, one end of the TEM will be cooled and the other end heated, and the cold/heat generated will be radiated to the surroundings via the cold/hot end radiators and fans. The cold end radiator and the cold end fan make up the inner circulation for internal cooling of the cabinet; the hot end radiator and the hot end fan make up the outer circulation for heat radiation to the external environment,.

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