

THERMOELECTRIC PRODUCTS CATALOGUE



CRYSTAL LTD.
2010

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)



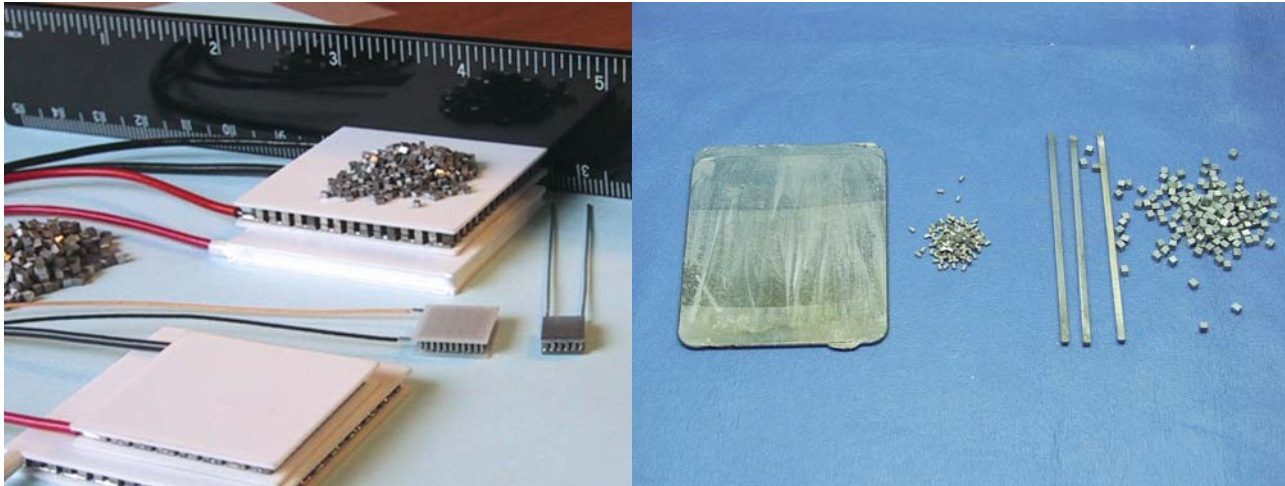
MISSION:

INTELLIGENT COOLING: YOUR VEHICLE, YOUR HOME, YOUR ENVIRONMENT

GOALS:

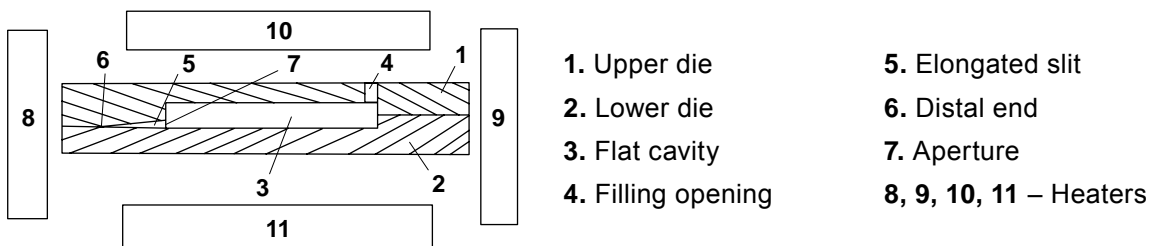
- **DEVELOPMENT, MANUFACTURE AND SALES OF STANDARD AND CUSTOMIZED THERMOELECTRIC PRODUCTS FOR HIGH PERFORMANCE APPLICATIONS.**
- **LEADING POSITIONS IN KEY MARKET SEGMENTS:**
 - LABORATORY & MEDICAL EQUIPMENT**
 - TELECOMMUNICATIONS**
 - AUTOMOTIVE APPLICATIONS**
 - MILITARY APPLICATIONS**
- **ORIENTATION 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



THERMOELECTRIC ELEMENTS

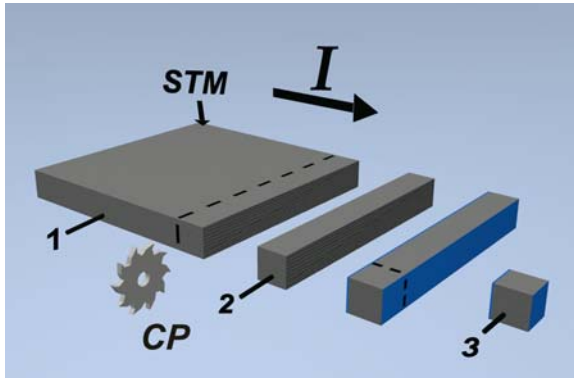
Since 1998 Crystal Ltd. has been producing thermoelectric elements of different cross-section and height. A unique technology allows growing the plates of thermoelectric material with defined width that forms one of the sizes of thermoelectric element (dice, pellet). It requires further only two cutting 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

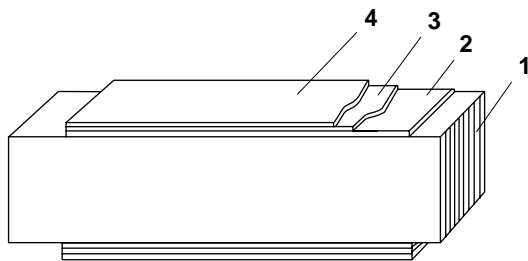
CP: Cutting plane

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

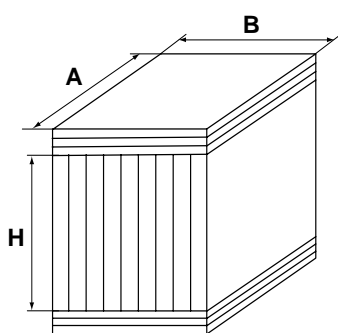
4. Protective layer

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, $\times 10^3 K^{-1}$, in vacuum (control samples with dimensions A, B = 1.40 mm, H = 1.60 mm)

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

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 90°C. A 140°C, 180°C 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 110°C. 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 140°C, 180°C, 219°C, 232°C 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 120°C and long-term “ON/OFF” operational mode. A 140°C, 180°C, 219°C, 232°C 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 150°C. A 140°C, 180°C, 219°C, 232°C melting point solders are recommended for the assembling process.

The coating composition:

Molybdenum, Mo:	0.05 ± 0.02 micron
Nickel, Ni:	10.0 ± 1.0 micron
Tin-Bismuth, Sn-Bi (Bi < 1 %):	7.0 ± 1.0 micron

TYPICAL ELEMENTS SIZE

Length / Width, mm	Height, mm	Figure of merit, 10^3K^{-1} , in vacuum	Electric conductivity, $Ohm^{-1}cm^{-1}$ at 25°C
0.40	0,5 ÷ 2,52	2,97 ÷ 3,05	850 ÷ 1 050
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			
2.40			

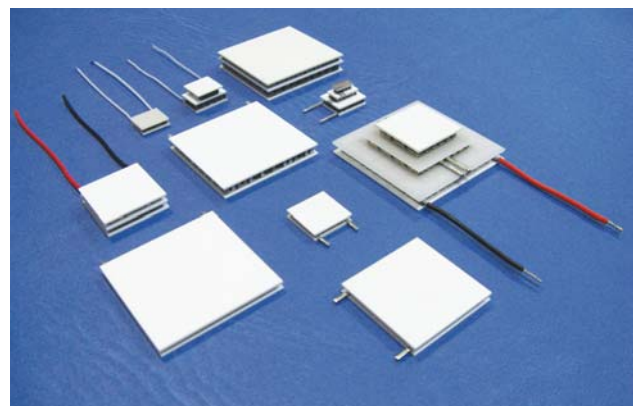
The elements can be made accordingly to customer's special requirements:

- Other dimensions available within ranges:
 - Width, Length – from 0,35 mm to 5,00 mm
 - Height – from 0,30 mm 3,00 mm
- Average electric conductivity value (for one batch) within range 850 ÷ 1150 $Ohm^{-1}cm^{-1}$
- Elements with heightened Figure of Merit (Z) = 3,05
- Electric conductivity tolerance in one batch of elements can be $\pm 3\%$
- 100% appearance inspection
- Tolerance of every dimension $\pm 0,01$ 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 (A x H) or (B x H)
- Elements with variable width
- Special design elements

THERMOELECTRIC COOLING (PELTIER) MODULES

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: S-127-14-16,L2,E

S	127	1.4	1.6	L2	E
Product series	Number of TE elements couples	Cross-section of elements, corresponds to 1,4 mm	Height of elements, corresponds to 1,5 mm	Thickness tolerance index	Sealing type

S, R, C, D, H – TYPICAL PRODUCT SERIES AVAILABLE

THICKNESS TOLERANCE INDEX

L1 – thickness tolerance $\pm 0,01$ mm

L2 – thickness tolerance $\pm 0,02$ mm

SEALING TYPE

S – silicon sealing;

E – epoxy sealing;

Absence of sealing index means modules without sealing.

NOTE! Max ΔT is reduced by 2-3°C for silicone and by 1-2°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

“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 $T_{hot} = 25^\circ C$)
- Cycling stability in ON-OFF power mode: over 10.000 cycles (cycle time is 60 seconds or more)
- Recommended operation current: 0.7 of I_{max}
- Recommended operation voltage: 0.8 of U_{max}
- Wires: UL-1569, PVC insulated

“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 $T_{hot} = 25^\circ C$)
- Cycling stability in ON-OFF power mode: over 30.000 cycles (cycle time is 60 seconds or more)
- Cycling stability in 20/80 power mode: over 10.000 cycles
- Mechanical strength
- Recommended operation current: 0.7 of I_{max}
- Recommended operation voltage: 0.8 of U_{max}
- Wires: UL-1569, PVC insulated

“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 $T_{hot} = 25^\circ C$)
- Cycling stability in ON-OFF power mode: over 40.000 cycles (cycle time is 60 seconds or more)
- Cycling stability in 20/80 power mode: up to 10.000 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 73°K (at $T_{hot} = 25^\circ C$)
- Cycling stability in ON-OFF power mode: over 10.000 cycles (cycle time is 60 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

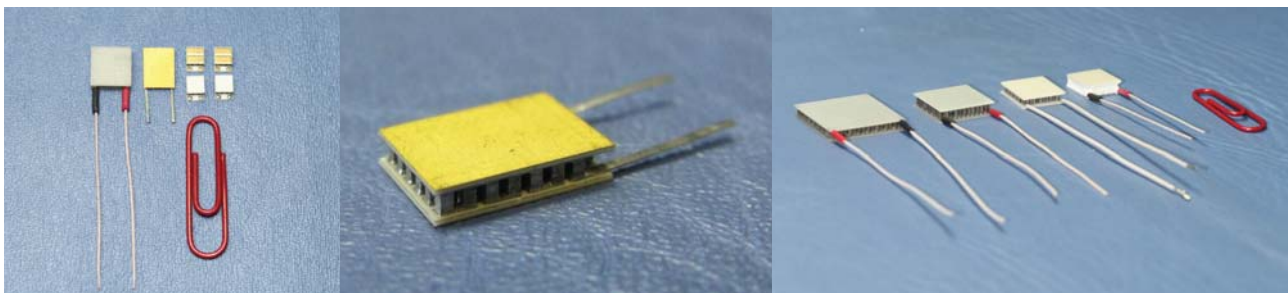
- Recommended operating temperature: up to 120°C
- Recommended operation current: 0.5–0.7 of I_{max}
- Cycling stability in ON-OFF power mode: over 40.000 cycles (cycle time is 60 seconds or more)
- Cycling stability in 20/80 power mode: up to 10.000 cycles

STANDARD THERMOELECTRIC MODULES

Other available series			Catalog Number in “S” – Series, “Standard”	$T_{hot} = 25^\circ C$				R_{AC} at 25 °C Ohm	Dimensions, mm		
				I_{max} , A	U_{max} , V	Q_{max} , Wt	ΔT_{max} , C		A	B	H
R	C	H	S-241-08-13	2,3	30,7	44	74,5	10,04	30	30	3,6
R	C	H	S-007-10-08	5,7	0,9	3,1	72,5	0,12	8	8	3,1
R	C	H	S-017-10-08		2,2	7,7		0,29	10	10	
R	C	H	S-031-10-08		3,9	13,9		0,52	15	15	
R	C	H	S-071-10-08		9	32	72,5	1,20	20	20	
R	C	H	S-127-10-08		16,2	57,6		2,13	30	30	
R	C	H	S-241-10-08		30,7	109,1		4,05	40	40	
R	C	H	S-007-10-13	3,4	0,9	2,1	74,5	0,20	8	8	3,6
R	C	H	S-017-10-13		2,2	5,1		0,47	10	10	
R	C	H	S-031-10-13		3,8	9,3	74,5	0,87	15	15	
R	C	H	S-063-10-13		8,0	18,8		1,76	15	30	
R	C	H	S-071-10-13		9,0	21,2		1,98	20	20	
R	C	H	S-127-10-13		16,2	37,9		3,55	30	30	
R	C	H	S-131-10-13		16,7	39,1		3,66	40	23	
R	C	H	S-241-10-13		30,7	71,8		6,73	40	40	
R	C	H	S-287-10-13		36,6	85,6		8,01	40	40	
R	C	H	S-007-10-15		3	0,9		1,8	74,5	0,23	
R	C	H	S-017-10-15	2,2		4,4	0,55	10		10	
R	C	H	S-031-10-15	3,9		8,1	74,5	1,00	15	15	
R	C	H	S-063-10-15	8,0		17		2,04	30	15	
R	C	H	S-071-10-15	9,0		18,6		2,29	20	20	
R	C	H	S-127-10-15	16,2		33,2		4,09	30	30	
R	C	H	S-241-10-15	30,7		63		7,77	40	40	
R	C	H	S-287-10-15	36,6		75		9,25	40	40	

R	C	H	S-007-10-25	1,8	0,9	1,1	75,5	0,38	8	8	4,8
R	C	H	S-017-10-25		2,2	2,6		0,92	10	10	
R	C	H	S-031-10-25		3,9	4,8		1,68	15	15	
R	C	H	S-071-10-25		9,0	11		3,84	20	20	
R	C	H	S-127-10-25		16,2	19,7		6,88	30	30	
R	C	H	S-241-10-25		30,7	37,4		13,04	40	40	
R	C	H	S-161-12-10	6,6	20,5	84,2	72,5	2,49	40	40	3,3
R	C	H	S-161-12-15	4,0	20,5	54,6	74,5	3,88	40	40	3,9
R	C	H	S-161-12-13	4,5	20,5	62,4	74,5	3,42	40	40	3,7
R	C	H	S-032-14-045	21,4	4,1	53,3	66	0,15	20	20	3,3
R	C	H	S-199-14-08	11,3	25,3	178,3	71	1,69	40(44)	40	3,5
R	C	H	S-007-14-11	7,8	0,9	4,5	72,5	0,09	10	10	3,8
R	C	H	S-017-14-11		2,2	11		0,21	15	15	
R	C	H	S-031-14-11		3,9	20		0,38	20	20	
R	C	H	S-071-14-11		9,0	45,9		0,87	30	30	
R	C	H	S-127-14-11		16,2	82,1		1,55	40	40	
R	C	H	S-199-14-11		25,3	128,6		2,43	40	40	
R	C	H	S-241-14-11	30,7	155,8	2,94	55	55			
R	C	H	S-007-14-15	5,5	0,9	3,3	74,5	0,12	10	10	3,9
R	C	H	S-017-14-15		2,2	7,9		0,30	15	15	
R	C	H	S-031-14-15		3,9	14,5		0,54	20	20	
R	C	H	S-071-14-15		9,0	33,2		1,24	30	30	
R	C	H	S-127-14-15		16,2	59,4		2,22	40	40	
R	C	H	S-199-14-15		25,3	93,1		3,49	40	40	
R	C	H	S-241-14-15	30,7	112,7	4,23	55	55			
R	C	H	S-059-14-15	6,0	7,6	27,9	74	0,93	29,5	24,5	4,5
R	C	H	S-007-14-25	3,5	0,9	2,1	75,5	0,19	10	10	4,8
R	C	H	S-017-14-25		2,1	5,2		0,46	15	15	
R	C	H	S-031-14-25		3,9	9,4		0,84	20	20	
R	C	H	S-071-14-25		9,0	21,6		1,92	30	30	
R	C	H	S-127-14-25		16,2	38,6		3,43	40	40	
R	C	H	S-241-14-25		30,7	73,2		6,51	55	55	
R	C	H	S-007-20-15	12,1	0,9	7,1	74,5	0,06	15	15	4,6
R	C	H	S-017-20-15		2,2	17,2		0,13	20	20	
R	C	H	S-031-20-15		3,9	31,4		0,25	30	30	
R	C	H	S-071-20-15		9,0	71,9		0,56	40	40	
R	C	H	S-127-20-15		16,2	128,7		1,00	55	55	
R	C	H	S-031-20-25	7,2	3,9	18,8	75,5	0,41	30	30	5,6
R	C	H	S-071-20-25		9,0	44		0,94	40	40	
R	C	H	S-127-20-25		16,2	78,7		1,68	55 (62)	55 (62)	

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



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

Other available series			Catalog Number	$T_{hot} = 25^{\circ}C$				R_{AC} at 25 °C, Ohm	Dimensions, mm		
				I_{max} , A	U_{max} , V	Q_{max} , Wt	ΔT_{max} , C		A	B	H
R	H	S-008-03-09	0,44	1	0,3	71,5	1,76	2,5	2,5	2,05	
R	H	S-018-03-09		2,3	0,6		3,95	3,5	3,5		
R	H	S-032-03-09		4,1	1,1		7,02	5	5		
R	H	S-007-05-15	0,8	0,9	0,4	74,5	0,88	4	4	3	
R	H	S-011-05-15		1,4	0,7		1,38	4	6		
R	H	S-017-05-15		2,2	1		2,14	6	6		
R	H	S-031-05-15		3,9	2		3,91	8	8		
R	H	S-065-05-15		8,3	4,2		8,20	11	12		
R	H	S-031-05-20	0,6	3,9	1,5	75,5	5,22	8	8	3,5	
R	H	S-018-055-09	1,53	2,3	2,2	71	1,15	6(7,6)	6	2	
R	H	S-007-06-11	1,4	0,9	0,8	72,5	0,46	4	4	2,7	
R	H	S-017-06-11		2,2	2		1,14	6	6		
R	H	S-018-06-11		2,2	2,1		1,25	6	6		
R	H	S-023-06-11		2,9	2,6		1,53	8,2	6		
R	H	S-029-06-11		3,7	3,3		1,93	10,2	6		
R	H	S-031-06-11		3,9	3,7		1,99	8	8		
R	H	S-068-06-11		8,7	7,8		4,53	13,2	13,2		
R	H	S-007-07-10	2,2	0,9	1,3	72,5	0,30	6	6	2,5	
R	H	S-011-07-10		1,4	2,0		0,47	6	8		
R	H	S-017-07-10		2,2	3,0		0,73	8	8		
R	H	S-031-07-10		3,9	5,5		1,33	10	10		
R	H	S-065-07-10		8,3	11,5		2,79	14	15		
R	H	S-007-07-15	1,5	0,9	0,9	74,5	0,45	6	6	3	
R	H	S-011-07-15		1,4	1,4		0,71	6	8		
R	H	S-017-07-15		2,2	2,2		1,10	8	8		
R	H	S-007-08-15	1,9	0,9	1,2	74,5	0,35	6	6	3,8	
R	H	S-017-08-15		2,2	2,8		0,84	9	9		
R	H	S-031-08-15		3,9	5,1		1,53	13	13		
R	H	S-063-08-15		8,0	10,4		3,10	25	12		
R	H	S-071-08-15		9,0	11,7		3,50	18	18	3,8	
R	H	S-127-08-15		16,2	20,9		6,25	25	25		
R	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: $\pm 5\%$. R_{AC} standard tolerance: $\pm 10\%$; $\pm 5\%$ is possible by request.

CENTER HOLE MODULES

Other available series			Catalog Number	$T_{hot} = 25^{\circ}C$				R_{AC} at 25 °C, Ohm	Dimensions, mm			
				I_{max} , A	U_{max} , V	Q_{max} , W	ΔT_{max} , C		A	B	d	H
R	C	H	S-038-10-13-RH	3,4	4,8	11,3	74,5	1,06	24	24	10	3,6
R	C	H	S-119-10-13-HS		15,2	35,5	74,5	3,32	30	30	4,7	3,6
R	C	H	S-125-14-11-HS	7,8	15,9	80,8	72,5	1,53	40	40	4,7	3,8
R	C	H	S-032-14-15-RH	5,5	4,1	15	74,5	0,56	55*	44	27	3,9
R	C	H	S-125-14-15-HS		15,9	58,5	74,5	2,19	40	40	4,7	3,9
R	C	H	S-014-14-25-RH	3,5	1,8	4,3	75,5	0,39	26	26	14	4,7

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

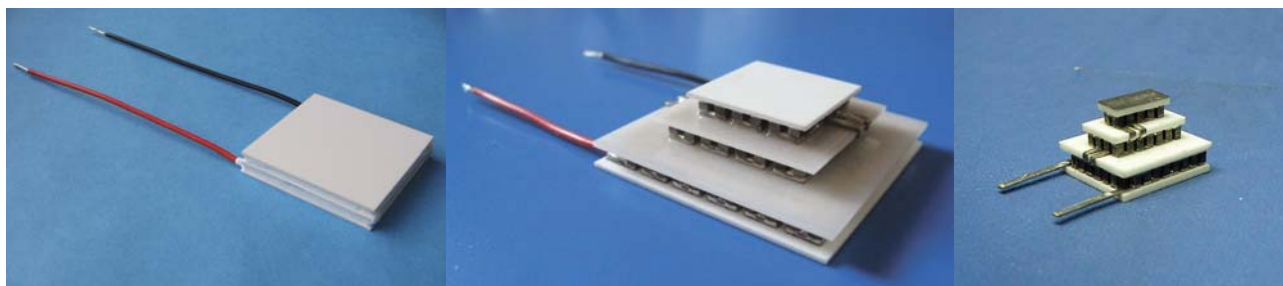
I_{max} , U_{max} , Q_{max} tolerance: $\pm 5\%$. R_{AC} standard tolerance: $\pm 10\%$; $\pm 5\%$ is possible by request

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

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	ΔT_{max} , C		A1	A	B	H
D-128-10-05	8,9	16,3	89,8	68	1,39	30	34	30	2,8
D-242-10-05		30,8	169,7		2,63	40	44	40	
D-288-10-05		36,7	201,9		3,13	40	44	40	
D-288-10-08	5,7	36,7	129,2	71	4,90	40	44	40	3,1
D-128-14-045	21,4	16,2	213,1	65	0,59	40	44	40	3,1
D-128-14-06	14,9	16,3	152,3	68	0,82	40	44	40	3,3
D-200-14-06		25,5	236,8		1,29	40	44	40	
D-242-14-06		30,8	285,9		1,56	52	56	52	
D-288-14-06		36,7	340,3		1,86	52	56	52	
D-200-14-11	7,8	25,5	125,4	71	2,43	40	44	40	3,8
D-288-14-11		36,7	180,0	71	3,56	52	56	52	
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.

“2” SERIES: POWERFUL TWO-STAGE 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	$T_{hot} = 25^{\circ}\text{C}$				R_{AC} at 25°C , Ohm	Dimensions, mm				
	I_{max} , A	U_{max} , V	Q_{max} , W	ΔT_{max} , C		A1	B1	A2	B2	H
2-010-06-11-L2	1,1	0,9	0,35	92	0,66	3,9	3,9	3,2	3,2	4,2
2-024-06-11-L2		2,2	0,81	92	1,58	6,1	6,1	4,1	4,1	4,6
2-049-10-15-L2	2,1	3,8	3,4	85	1,58	15	15	11,5	11,5	6,6
2-190-10-12-L2	2,8	15,7	16,4	85	4,92	30	30	30	30	6,5
2-049-14-15-L2	4,0	3,8	6,6	85	0,85	20	20	15	15	7,2
2-176-14-15-L2	4,6	15,7	22,5	90	3,19	40	40	40	40	7,2
2-192-1420-1118-L2	6,7	15,6	39,3	84	2,21	40	40	40	40	8,1
2-192-1420-1425-L2	4,4	16,0	27,3	85	3,12	40	40	40	40	8,1
2-196-19-14-L2	8,5	16,1	51,6	84	1,70	40	40	40	40	7,0
2-199-20-15-L2	9,3	15,6	57,1	84	1,62	62	62	62	62	8,9

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

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