Thermocouple (T/C) 热电偶

Construction of thermocouple (热电偶构造)

热电偶的动作原理也就是所谓的"席贝克效应"，假使导线两端有温度差，将会造成电流流动，电流的多寡取决于选择的材质。

将两种不同金属材质连接在一起并加热此端，导线另两端将会产生电压差。若要测量温接点温度，导线另两端的参考温度需要得知，若导线另两端参考温度不能得知，需将导线延伸到可知的温度点，作为参考点(一般称为冷接点)。

此参考点的温度是可知的系数，将参考点(冷接点)和温接点温度相加即是所测的实际温度。

热电偶测温原理

如下图，选用两种不同的金属或合金丝A，B，称为热电极，焊接的一端称为测量端，连线显示仪表的两头称为参比端，当测量端和参比端温度不同时，就会产生热电势Eab(t,t1)，当t=0℃时则有：

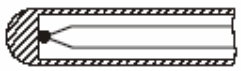
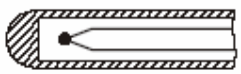
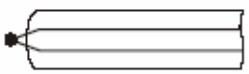
Eab(t,0)=Eab(t)=f(t)

The effect responsible for the action of thermocouple is the" Seebeck effect " . If a temperature difference exists along a wire , this will causes a displacement of electrical charge . The amount of the charge displacement depends on the electrical characteristics of the chosen material.

If two wires of different materials are joined at one point and then subjected to a temperature , then a voltage difference will be generated between the open ends of the two wires . In order to be able to measure the temperature at the junction, the temperature at the open end must be known. If the temperature of the open end is not known, then it must be extended (by a compensating cable) into the zone of known temperature (reference junction, usually referred to as the "cold junction").

The temperature of the reference junction must be known and constant. the exact temperature is equal joined junction temperature plus cold junction temperature .

TYPE OF MEASURING JUNCTION (测温接点种类)

TYPE (种类)	SHAPE (形状)	FEATURE (特长)
Grounded (接地型)		1. This type can withstand 3500kg/cm2 or more 此型能耐压3500kg/cm2 以上 2. It is not suitable for location with electromagnetic induction on radio frequency inter-ference 不适用于电磁波干扰之场所
Ungrounded (非接地型)		1. This type has a slower reponse than the grounded type but is more commonly used since it is not restricted by the object to be measured 反应速率比接地型慢，但较为广泛使用，被测物较不受限制。 2. The element is covered with an insulator thereby ensuring a long life span . 元件由绝缘体保护，寿命较长。
Exposed (露出型)		1. Since the element is exposed reposed reponse time is very fast 元件是露出型，反应速率非常快。 2. This type is suitable for temperature measurment of gases such as automotive exhaust . 非常适用气体测量，例如：废气。 3. This type is mechanically weaker than the other. 机械架构比其他类型脆弱。

MINERAL INSULATED THERMOCOUPLE (金属被覆热电偶)

1. wide application in measuring small diameter is very useful for the place where space is at premium .
   应用范围广，受空间限制小直径特别有用。
2. quick response 反应速率快。
3. easily bent for installation 可挠性大。
4. long life span 寿命长。
5. excellent mechanical strength and pressure resistance 机械强度及耐压性强。

standard specification of **AEROPAK ®** sheath therm ocouple

	sheath (mm)		wire dia (mm) 素线径	maximum length (M) 最大长度(米)
	O.D 外径	t 肉厚		
SINGLE ELEMENT (单组) 	Ø 0.25	0.035	Ø 0.05	138
	Ø 0.5	0.08	Ø 0.1	95
	Ø 1.0	0.17	Ø 0.17	420
	Ø 1.6	0.27	Ø 0.27	185
	Ø 3.2	0.47	Ø 0.51	130
	Ø 4.8	0.72	Ø 0.76	142
	Ø 6.4	0.93.	Ø 1.0	80
	Ø 8.0	1.16	Ø 1.3	50
DOUBLE ELEMENT (双组) 	Ø 3.2	0.47	Ø 0.51	130
	Ø 4.8	0.72	Ø 0.76	142
	Ø 6.4	0.93	Ø 1.0	80
	Ø 8.0	1.16	Ø 1.3	50
TRIPLE ELEMENT (叁组) 	Ø 4.8	0.72	Ø 0.5	142
	Ø 6.4	0.93	Ø 0.72	80
	Ø 8.0	1.16	Ø 0.9	50

AEROPAK ® OPERATING TEMPERATURE RANGE (IN AIR) 大气中使用温度范围

SHEATH O.D 外径 (mm)	SN	SK			SE	SE	SJ	ST
Ø 0.25	-	500 °C *1)			-	-	-	-
Ø 0.5	-	600 °C (1)			-	-	-	-
Ø 1.0	900 °C (*3)	650 °C		900 °C (*3)	650 °C	450 °C	450 °C	300 °C
Ø 1.6	1200 °C (*3)	650 °C		1200 °C (*3)	650 °C	450 °C	450 °C	300 °C
Ø 3.2	1260 °C (*3)	750 °C		1260 °C (*3)	750 °C	650 °C	650 °C	350 °C
Ø 4.8	1260 °C (*3)	800 °C		1260 °C (*3)	800 °C	750 °C	750 °C	350 °C
Ø 6.4	1260 °C (*3)	1000 °C (*1)	600 °C (*1)	900 °C (*2)	800 °C	750 °C	750 °C	350 °C
Ø 8.0	-	1050 °C (*1)	600 °C (*1)	1000 °C (*2)	800 °C	750 °C	750 °C	350 °C

(*1) sheath material : NCF 600 (*2) sheath material : SUS310 (*3) sheath material : H2300 OTHERS : SUS316
(*1) sheath 材质 : NCF 600 (*2) sheath 材质 : SUS310 (*3) sheath 材质 : H2300 未注记：SUS316

FEATURE OF THERMOCOUPLE 热电偶特性

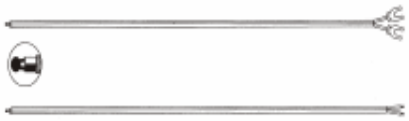
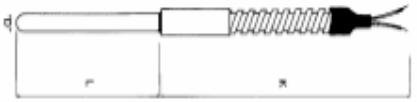
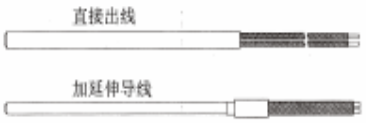
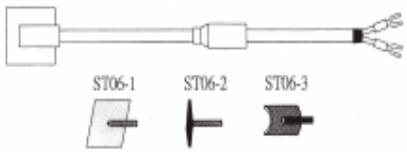
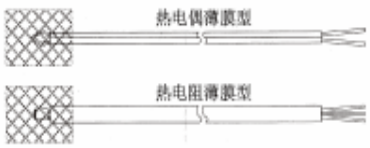
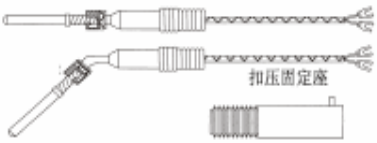
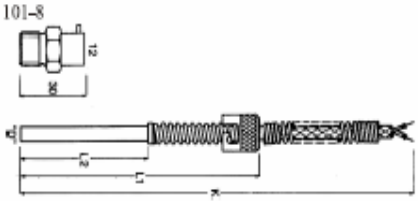
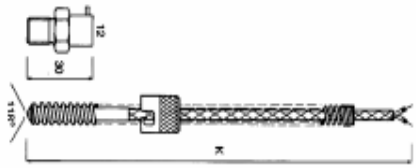
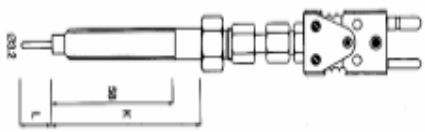
type	feature	优 点	缺 点
B	Thermocouple which combines a positive wire of a platinum-rhodium alloy containing 70% platinum and 30% rhodium with a negative wire of platinum rhodium containing 94% platinum and 6% rhodium. Type B is more resistant to heat and mechanical stress than type R, and withstands 1800°C Max. Other features are the same as those of type R.	1. 适用1000℃以上至1800℃之高温测定。 2. 在常温环境下热电动势非常小，不需补偿导线。 3. 耐氧化、耐药品性良好。 4. 耐热性与机械强度较R型优良。	1. 在中低温域之热电动势极小，600℃以下测定温度不准确。 2. 感度不佳(热电动势值小)。 3. 热电动势之直线性不佳。 4. 价格高昂。
R & S	Thermocouple which combines a positive wire of a platinum and rhodium alloy containing 87% platinum and 13% rhodium with a negative wire of pure platinum. This thermocouple is highly accurate, excellent in heat resistance and stability, generally used in oxidizing atmospheres. It is not recommended for use in reducing atmospheres or where metal vapors are present. Thermocouple which combines a positive wire of a platinum rhodium alloy containing 90% platinum and 10% rhodium with a negative wire of pure platinum. Other features are the same as those of type R.	1. 耐热性、安定性、再现性良好及较优越的精确度。 2. 耐氧化、耐药品性良好。 3. 可以做为标准使用。	1. 感度不佳(热电动势值小)。 2. 在还元性气体环境较脆弱。(特别是氢、金属蒸气) 3. 补偿导线误差大。 4. 价格高昂。
N	This is called Nicrosil (positive leg) / Nisil (negative leg) Thermocouple, and its composition and characteristics are very similar to those of type K Thermocouple. It is an improved type of Type K Thermocouple and has more Si additive, higher heat resistance.	1. 热电动势之直线性良好。 2. 1200℃以下耐氧化性良好。 3. 为K型之改良型，受Green Rot之影响较小，耐热温度较K型高。	1. 不适用于还元性气体环境。 2. 热电动势与贵金热电偶相比较轻时变化较大。
K	Thermocouple which combines a positive wire of an alloy consisting mainly of nickel and chromium with negative wire of an alloy consisting mainly of nickel. This thermocouple widely used for many particularly should not be used in carbon monoxide, sulfurous acid gas or sulfur bearing hydrogen atmospheres.	1. 热电动势之直线性良好。 2. 1000℃下耐氧化性良好。 3. 在卑金属热电偶中安定性属良好。	1. 不适用于还元性气体环境，特别是一氧化碳、二氧化硫、硫化氢等气体。 2. 热电动势与贵金属热电偶相比较轻时变化较大。受Short Range Ordering之影响会产生误差。
E	Thermocouple which combines a positive wire of thermocouple K with a negative wire of thermocouple J. This thermocouple has a high thermal emf and is suitable for use in oxidizing atmosphere.	1. 现有热电偶中感度最佳者。 2. 与J热电偶相比耐热性良好不具磁性。 3. 适于氧化性气体环境。	1. 不适用于还元性气体环境。 2. 稍具履历现象。
J	Thermocouple which combines a positive wire of iron with thermocouple is resistant in reducing atmospheres and is also resistant to hydrogen and carbon. However it should not be used in atmospheres that will oxidize iron. It is relatively low in cost and often used for medium temperature range applications.	1. 可使用于还元性气体环境。 2. 热电动势较K热电偶大20%。 3. 价格较便宜，适用于中温区域。	1. (+)脚易生锈。 2. 再现性不佳。
T	Thermocouple which combines a positive wire of copper with a negative wire of an alloy mainly of copper and nickel. High accuracy is obtained at under 300°C, and it is suitable for low temperatures from -200°C to +100°C. It is suitable for use in weak oxidizing and reducing atmospheres.	1. 热电动势之直线性良好。 2. 低温之特性良好。 3. 再现性良好、高精度。 4. 可使用于还元性气体环境。	1. 使用温度限度低。 2. (+)脚之铜易氧化。 3. 热传导误差大。

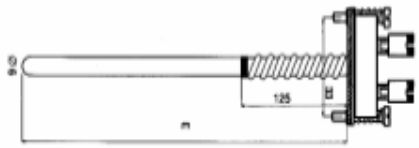
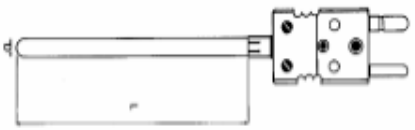
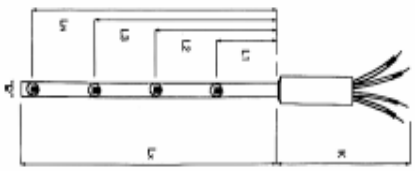
Thermocouple tolerance and applicable standards (热电偶精确度及应用标准)

standard 规格 / symbol 种类	COMPOSITION 构成材料 (+ / -)	JIS C 1602-1995			IEC 584-2-1982		ASTM E230-1996		
		TEMP RANGE 温度范围	CLASS 等级	TOLERENCE 误差℃	CLASS 等级	TOLERENCE 误差℃	TEMP RANGE 温度范围	CLASS 等级	TOLERENCE 误差℃
B	Pt-30Rh / Pt-6Rh 铂-30%铑/ 铂-6%铑	600℃ ~ 1700℃	2	± 0.0025|t|	2	± 0.0025|t|	870℃ ~ 1700℃	STD	± 0.5 %
		600℃ ~ 800℃	3	± 4	3	± 4			
		800℃ ~ 1700℃		± 0.005|t|		± 0.005|t|		
R & S	(R)Pt-13Rh / Pt 铂-13% 铑/铂	0℃ ~ 1100℃	1	± 1	1	± 1	0℃ ~ 1450℃	STD	± 1.5 OR ± 0.25 %
	(S)Pt-10Rh / Pt 铂-10% 铑/铂	0℃ ~ 600℃	2	± 1.5	2	± 1.5		SP	± 0.6 OR ± 0.1 %
		600℃ ~ 1600℃		± 0.0025|t|		± 0.0025|t|		
N & K	(N) Ni-Cr-Si / Ni-Si 镍-铬-硅/镍-硅 (K)Ni-Cr / Ni-Al 镍-铬/镍-铝	-40℃ ~ +375℃	1	± 1.5	1	± 1.5	0℃ ~ 1260℃	STD	± 2.2 OR ± 0.75 %
		+375℃ ~ 1000℃		± 0.004|t|		± 0.004|t|		
		-40℃ ~ +333℃	2	± 2.5	2	± 2.5		SP	± 1.1 OR ± 0.4 %
		+333℃ ~ 1200℃		± 0.0075|t|		± 0.0075|t|		
		-167℃ ~ +40℃	3	± 2.5	3	± 2.5	-200℃ ~ 0℃	STD	± 2.2 OR ± 2 %
		-200℃ ~ -167℃		± 0.015|t|		± 0.0015|t|		
E	Ni-Cr / Cu-Ni 镍-铬/铜-镍	-40℃ ~ +375℃	1	± 1.5	1	± 1.5	0℃ ~ +870℃	STD	± 1.7 OR ± 0.5 %
		+375℃ ~ 800℃		± 0.004|t|		± 0.004|t|		
		-40℃ ~ +333℃	2	± 2.5	2	± 2.5		SP	± 1 OR ± 0.4 %
		+333℃ ~ +900℃		± 0.0075|t|		± 0.0075|t|		
		-167℃ ~ +40℃	3	± 2.5	3	± 2.5	-200℃ ~ 0℃	STD	± 1.7OR ± 1 %
		-200℃ ~ -167℃		± 0.015|t|		± 0.015|t|		
J	Fe / Cu-NI 铁 / 铜-镍	-40℃ ~ +375℃	1	± 1.5	1	± 1.5	0℃ ~ +760℃	STD	± 2.2OR ± 0.75 %
		+375℃ ~ 750℃		± 0.004|t|		± 0.004|t|		
		-40℃ ~ +333℃	2	± 2.5	2	± 2.5		SP	± 1.1 OR ± 0.4 %
		+333℃ ~ +750℃		± 0.0075|t|		± 0.0075|t|		
T	Cu / Cu-Ni 铜 / 铜-镍	-40℃ ~ +125℃	1	± 0.5	1	± 0.5	0℃ ~ +370℃	STD	± 1.1 OR ± 0.4 %
		+125℃ ~ +350℃		± 0.004|t|		± 0.004|t|		
		-40℃ ~ +133℃	2	± 1.0	2	± 1.0		SP	± 0.5 OR ± 0.4 %
		+133℃ ~ +350℃		± 0.0075|t|		± 0.0075|t|		
		-67℃ ~ +40℃	3	± 1.0	3	± 1.0	-200℃ ~ 0℃	STD	± 1 OR ± 1.5 %
		-200℃ ~ -67℃		± 0.015|t|		± 0.015|t|		

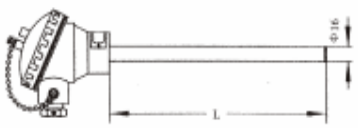
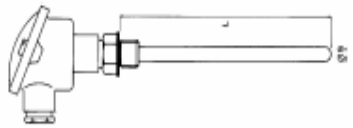
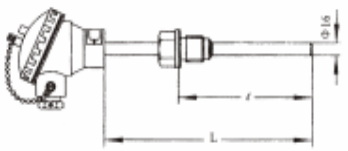
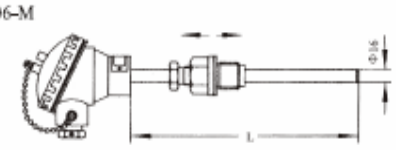
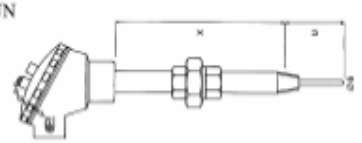
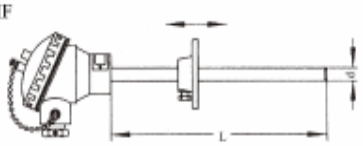
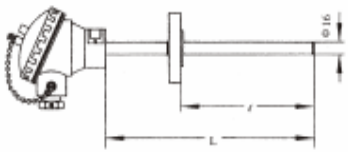
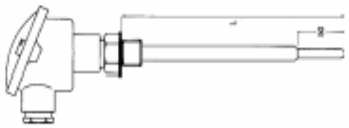
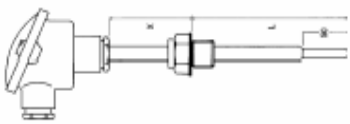
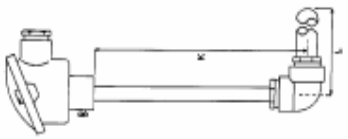
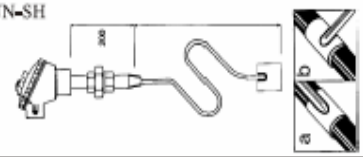
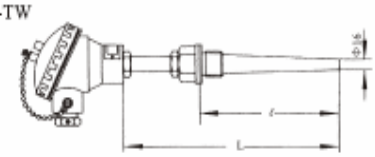
(1)Tolerance is referred to as the maximum allowable deviation between measuring junction temperature and the temperature derived from the emf table.
(2)ASTM tolerance is ℃ or % value for the measured temperature, whichever is greater
(3)|t| means measuring temperature indicated with the temperature (℃) having no connection with the positive or negative mark.
(4) Classes 1, 2, 3 correspond to former JIS Classes 0.4, 0.75, 1.5 respectively.
.(5)JIS, BS, DIN standards are same as IEC standard.
(6)ASTM standard is former ANSI standard.

1. 容许差为热电动势依基准热电动势表所换算之温度减去测温接点之温度之容许最大限度。
2. ASTM之容许差为℃或是测定温度之百分比(%)中之最大值。
3. t 表测定度其无关 + 、 − 符号之温度(℃)绝对值。
4. CLASS1、2、3对应于旧丕之04、0.75、15级。
5. JIS、BS、DIN规格与IEC规格相同。
6. ASTM规格为旧ANSI规格。

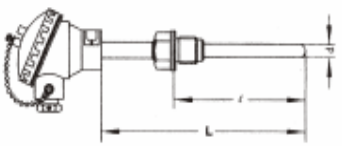
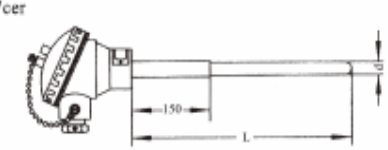
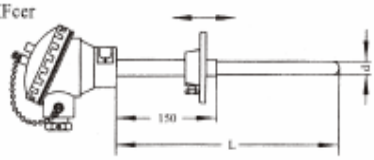
melt bolt thermocouple 尖端点焊型	thermocouple wire with ceramic insulator 素线外覆绝缘瓷管
CMT 100 	CMT 007 热电偶素线型加绝缘套管  CMT 027 热电阻加绝缘套管 
armor thermocouple extension 金属蛇管延长型	screw Thermocouple 螺丝攻入型(1)
CMT 103 	CMT 101B 
flexible thermocouple extension 延长型	spade thermocouple 片状型
CMT 101-6 直接出线 加延伸导线 	ST 30-PAD 
Ring Thermocouple 扣环型	spring adjustable immersion thermocouple 弹簧可调浸入型
CMT 101R 热电偶薄膜型 CMT 201R 热电阻薄膜型 	CMT 105 
spring ajustable immersion T/C 弹簧可调浸入型	spring adjustable immersion T/C 弹簧可调浸入型
CMT 101-8 	CMT 101-26 
Plug T/C 快速接头热电偶	plug thermocouple 快速接头热电偶
ST 70-1 	CMT 101C1  CMT 101C2 

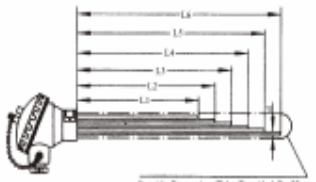
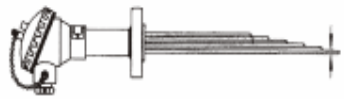
plug T/C 快速接头热电偶	Flxible fitting with D coector thermocouple 活动牙口加D型接头
ST 70-FE 	ST 60 
DIN terminator T/C DIN端子板热电偶	plug T/C 快速接头热电偶
SF 70-S 	ST 70-M 
Muti points T/C 多点感热电偶	DIN terminator thermocouple DIN端子板 T/C
ST 703 	ST 70-DIN 
T terminator thermocouple T型接线端子	Round plate T/C 圆板热电偶
ST 70-T 	ST 70-R 

model 型号 CMT		100, 007, 103, 101B, 101-6, ST 30-PAD, 101R, 105, 101-26, 101-8, 101-C1, 101-C2, ST 60, ST 70-1, ST 70-M, ST 70-FE, ST 70-DIN, ST 70-S, ST 70-T, ST 703, ST 70-R
type of element 类 型		J=J type , K=K type ,E =E type , T=T type , R =R type ,S =S type , N =N type , B=B type
element quantity 测温点数量		S=Single , D=DUAL , O=OTHER
process connection parts 制程接和附件		5 =None , 7=fixed type bushing , 8=compression fitting , 9=compression fitting with bushing 10=compression fitting with bayonet cap and spring (Page 20,21) if need connection parts , please note connection size : ____ inch (PT , NPT, G , R)
terminal connector 接线端子		O=O type Y=Y type, T=T connector, S=standard connector, M=mini connector (Page 18,19)
probe material 外管材质		S4=SUS304 , S6=SUS316, S10 = SUS310 , NCF=INCONEL 600 , CERA=ceramic
probe diameter 外管直径		Ø1.0 mm , Ø1.6 mm , Ø2.3 mm , Ø3.2 mm , Ø4.8 mm , Ø6.4 mm , Ø 9 mm , Ø12.7 mm , Ø21.7 mm ,specify
probe length 外管长度		_____ mm
lead wire length 导线长度		flexible SUS316 tube armor length (if need) + leadwire length
lead wire insulated material 导线绝缘材质		PVC, fiber glass, teflon (page 25,26,27)
measuring junction 测温点型式		G=Ground , UG=Ungrounded , EPS=Exposed type
CLASS 等级		01=JIS0.4 , 02=JIS0.75 , 03=JIS1.5 , 04=ASTM standard , 05=ASTM special

无固定装置式金属保护管热电偶Non-fixed Type TC With Metallic Protection Tube	固定螺栓式热电偶 Fixed Screw-In Type T/C
CMT 107 	CMT 106 
固定螺栓式热电偶 Fixed Screw-In Type T/C	活动螺栓式热电偶 Movable Screw-In T/C
CMT 106-1 	CMT 106-M 
延长型热电偶 extensio Type TC	活动法兰式热电偶 Movable Fiange Type TC
CMT 106-UN 	CMT 107-MF 
固定法兰式热电偶 Fixed Flange Type Tc	固定螺栓变径型热电偶 Fixed Screw-in type T/C With Variable diameter
CMT 107-F 	CMT 106-IV1 
固定螺栓变径型热电偶 Fixed Screw-in type T/C With Variable diameter	角尺式热电偶 Right angle Type T/C
CMT 106-IV2 	CMT 106-L 
延长型sheath热电偶 extensio sheath Type T/C	固定螺栓锥形保护管式热电偶 Fixed Screw-In Type TC With Tapered Drilled Thermowell
CMT 106-UN-SH 	CMT 107-TW 

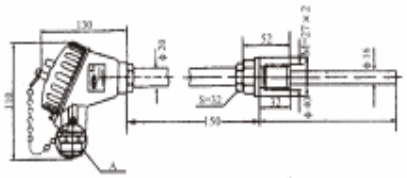
非金属保护管 Non-Metalic protection tube

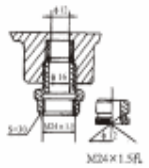
固定螺栓式瓷保护管热电偶 Fixed Screw-In Type TC With Protection Type	无固定装置式瓷保护管热电偶 Non-Fixing Type TC With ceramic Prorection Tube
CMT 106cer 	CMT 107cer 
	活动法兰式瓷保护管热电偶Movable Flange Type TC With Ceramic Protection Tube
	CMT 107MFcer 

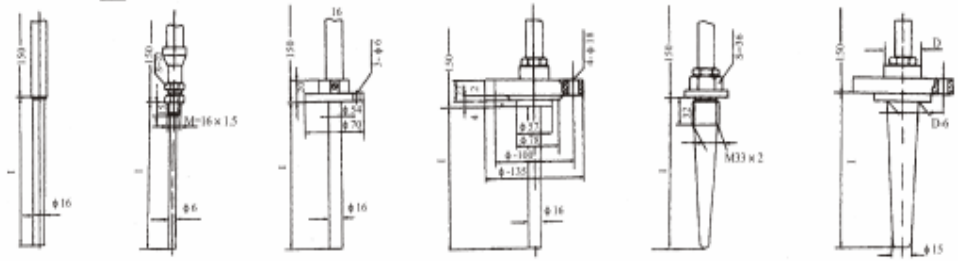
型 号	无固定装置多点式 Non-Fixed Type Multiple Point	型 号	固定法兰多点式 Fixed Flange Type Multiple Point
CMT 307		CMT 307F	

注：各点长度均可任意选择，点数可根据需要增减，一般多点式热电偶分三点、四点、五点、六点四种规格。

Note: Length and / or measuring points can be chosen as needed. Regularmultiple TC has four specifications: 3、4、5 and 6 points.







无固定装置　固定卡套螺纹　活动法兰　固定法兰　高压螺纹　高压法兰

model 型 号 CMT		106, 107, 106-1, 106M, 106UN, 107MF, 107F, 106-IV1, 106-IV2, 106-L, 106-UNSH, 106-ITW, 106 cer, 107 cer, 107MF cer, 307, 307F
type of lement 种　类		J=J type , K=K type ,E =E type , T=T type , R =R type ,S =S type , N =N type B=B type
element quantity 测温点数量		S=Single , D=DUAL , O=OTHER
probe extension & connection type 测温管接和方式		5 =None , 6NUN=nipple-union-nipple , 6N=Nipple, 6NU=nipple-union 7=fixed type bushing , 8=compression fitting , 9=compression fitting with bushing (Page 19,20,21) if need extension parts , please note extension length = ___ mm & connection size : ____ inch PT (or other) ,
spring loaded 弹簧伸缩		0=with , 1=without
terminal head 接线盒		KB , KNC , KI , KD , KT , LS, 1080AE(explosion) ,1080SE(explosion) Page(18)
PROBE MATERIAL 测温管材质		S4=SUS304 , S6=SUS316, S10 = SUS310 , NCF=INCONEL 600　CERA : Ceramic, other
probe diameter 测温管直径		Ø1.0 mm , Ø1.6 mm , Ø2.3 mm , Ø3.2 mm , Ø4.8 mm , Ø6.4 mm , Ø9 mm , Ø12.7 mm , Ø21.7 mm ,specific
probe length 测温管长度		_____ mm
measuring junction 测温点种类		G=Ground , UG=Ungrounded , EPS=Exposed type
CLASS 等级		01=JIS0.4 ,02=JIS0.75 03=JIS1.5 , 04=ASTM standard , 05=ASTM special
THERMOWELL 保护套管		TW=with thermowell NTW=without thermowell (see page 22,23,24)