시-즈 열전대

SHEATH THERMOCOUPLE

AEROPAK 시-즈 열전대

스텐레스강이나 내열강으로 만든 작은 관(시-즈)안에 열전대 소선을 넣고 그 주위를 무기 절연물인 산화마그네슘으로 충진한 것입니다.

열전대의 원리

열전대는 종류가 다른 2개의 금속선의 양단을 접속한것으로 이 양단의 접점에 온도차가 발생 했을때 이 폐회로에 열기전력이 발생하고 회로에 전류가 흐릅니다.
이 열기전력의 크기와 극성은 양단의 온도와 2개의 금속선 조합에 따라 결정되고, 금속선의 굵기와 길이와는 영향이 없습니다.
따라서 특정의 열전대 각온도에 있어서 열전기전력을 미리 알고자 하는 온도를 측정 하는 것이 가능 합니다.

특징

종래의 보호관 열전대와 비교하면 다음과 같은 특징이 있습니다.

1. 넓은 응용 범위
   외경이 가늘기 때문에 작은 측정물의 온도도 측정이 가능합니다. 또 시-즈 형태 구조에 의해 고온고압에 견디고, -200 ~ 1050℃까지 넓은 온도 범위에 사용이 가능합니다.

2. 빠른 응답성
   작은 외경은 열용량이 작기 때문에 온도 변화에 민감하게 응답한다.

3. 취급이 쉽다
   가장 작게 휘어짐은 외경의 2배 입니다. 현장에 있어서도 쉽게 이러한 장소에 취부가 가능합니다.

4. 수명이 길다
   종래의 열전대와 비교하여 기전력의 노화나 단선등의 사고에 대하여 화학적으로 안정한 산화마그네슘으로 절연되여 기밀을 보호하고 있기 때문에 수명이 깁니다.

5. 기계적 강도와 내압성
   고진동, 내식성분위기, 고온, 저온장소에서도 시-즈재질을 선정하므로서 안심하여 사용이 가능합니다.
   외경이 아주 작은 시-즈에서도 650℃에서 약 350Mpa 내압 강도가 있습니다.

note – AEROPAK은 OKAZAKI 등록상표임

AEROPAK MINERAL INSULATED THERMOCOUPLE

AEROPAK is a trade mark for our metal sheathed ceramic insulated cable and thermocouples. The AEROPAK construction result in thermocouples wires that are surrounded by a compacted mineral insulation (MgO) and contained in a sheath such as stainless steel or heat resisting steel. On the basis of this AEROPAK construction, a wide variety of otherwise difficult applications are possible. Compared with general-purpose (Protection tube type) thermocouples, sheathed thermocouples have many advantages.

Basic thermocouple theory

A thermocouple is a closed loop circuit that consists of two dissimilar metal wires welded together at both ends. When a temperatune difference exists between the two junctions, thermal electromotive force (EMF) is generated and an electric current flows in the closed circuit. The direction and magnitude of the EMF generated depend upon the tempemture of the two junctions and upon the materials making up the thermocouple, and are not affected by the size or length of the thermocouple wire. Temperatune can be measured by knowing beforehand the change of EMF per degree change of temperature for a certain thermocouple.

Features

AEROPAK thermocouples have the following advantages over conventional protection tube or wire-insulator styles.

1. A wide application in measurement
Small diameter thermocouple is very usefull for the place where space is at premium. AEROPAK construction is resistant to high pressure and also used at wide range of temperature from -200°C to +1050°C.

2. Quick response
AEROPAK thermocouples have small heat capasity due to the small sheath size, The small thermal mass is highly sensitive to change in temperature and gives a very fast response.

3. Easily bent for installation
The ability to form AEROPAK thermocouples on a radius twice the sheath diameter makes for simple and on-the-spot installation into complex configurations.

4. Long life span
Contrary to conventional thermocouples which suffer from deterioration of electromotive force or wire disconnection, etc., AEROPAK thermocouples wires are insulated with chemically stable magnesium oxide, thus assuring a longer service life.

5. Excellent mechanical strength and pressure resistance
The composite construction is resistant to extreamely high vibration levels, and by choosing appropriate sheath material, it is reliable to use in corrosive atmospheres and abnormally high or low temperatures,. Though it has small diameter, it can be withstand about 350MPa at a temperature of 650°C.

6. 제조 가능 시-즈 외경
0.1mm ~ 12.7mm 시-즈 외경을 제조 할수 있습니다.

7. 제조가능 시-즈 길이
시-즈 외경에 따라 약 400m 까지 제조가능합니다.

8. 특수요구 대응

6. Custom sheath outer diameter available
Sheath outer diameter sizes between 0.25mm and 12.7mm can be provided.

7. Custom long length
Length are available up to a maximum of 400m. Maximum length is dependent upon the sheath outer diameter.

8. Compatible with special needs
We have our own factory for making many kinds of metalic sheathed cables, therefore, we can correspond to various needs from customers.

Component Material of Thermocouple
열전대소선의 구성재료

JIS C1605-1995

Symbol 기호	Positive Polarity	Negative Polarity
SN (N)	니켈, 크롬및 실리콘을 주로한 합금 Alloy consisting mainly of nickel, chromium and silicone	니켈 및 실리콘을 주로한 합금 Alloy consisting mainly of nickel and silicone
SK (K)	니켈 및 크롬을 주로한 합금 Alloy consisting mainly of nickel and chromium	니켈을 주로한 합금 Alloy consisting mainly of nickel
SE (E)	니켈 및 크롬을 주로한 합금 Alloy consisting mainly of nickel and chromium	동 및 니켈을 주로한 합금 Alloy consisting mainly of Copper and nickel
SJ (J)	철 Iron	동 및 니켈을 주로한 합금 Alloy consisting mainly of Copper and nickel
ST (T)	동 Copper	동 및 니켈을 주로한 합금 Alloy consisting mainly of Copper and nickel,

Operating Temperature Range (In Air)
AEROPAK 사용온도범위 (대기중)

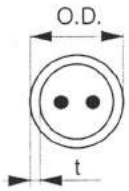
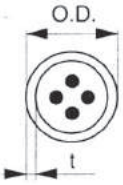
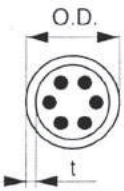
Unit
단위 : ℃

Sheath O.D. 사-즈 외경	SN	SK			SE	SJ	ST
φ0.25	—	*1 500			—	—	—
φ0.5	—	*1 600			—	—	—
φ1.0	*3 900	650		*3 900	650	450	300
φ1.6	*3 1200	650		*3 1200	650	450	300
φ3.2	*3 1260	750		*3 1260	750	650	350
φ4.8	*3 1260	800		*3 1260	800	750	350
φ6.4	*3 1260	*1 1000	*2 900	*3 1260	800	750	350
φ8.0	—	*1 1050	*2 1000	—	800	750	350

* 1인 시-즈 재질은 NCF600
* 2인 시-즈 재질은 SUS310S
* 3인 시-즈 재질은 H2300
* 무인 시-즈 재질은 SUS316

Standard Specifications of AEROPAK Sheath Thermocouple

AEROPAK 시-즈 열전대의 표준사양

	Sheath 시-즈 (mm) O.D. 외경	Sheath 시-즈 (mm) t 두께	Wire dia. 소선경 (mm)	Type of Thermocouple and Sheath Material 열전대종류와 시-즈 재질 SN Sheath material	SK Sheath material	SE Sheath material	SJ Sheath material	ST Sheath material
Single Element 	φ0.25	0.035	φ0.05	—	NCF600	—	—	—
	φ0.5	0.08	φ0.1	—	NCF600	—	—	—
	φ1.0	0.17	φ0.17	H2300	SUS316 H2300	SUS316	SUS316	SUS316
	φ1.6	0.27	φ0.27	H2300	SUS316 H2300	SUS316	SUS316	SUS316
	φ3.2	0.47	φ0.51	H2300	SUS316 H2300	SUS316	SUS316	SUS316
	φ4.8	0.72	φ0.76	H2300	SUS316 H2300	SUS316	SUS316	SUS316
	φ6.4	0.93	φ1.0	H2300	SUS310S NCF600 H2300	SUS316	SUS316	SUS316
	φ8.0	1.16	φ1.3	—	SUS310S NCF600 Hastelloy-X	SUS316	SUS316	SUS316
	φ3.2	0.47	φ0.51	—	SUS316 H2300	SUS316	SUS316	—
	φ4.8	0.72	φ0.76	—	SUS316 H2300	SUS316	SUS316	SUS316
	φ6.4	0.93	φ1.0	—	SUS310S NCF600 H2300	SUS316	SUS316	SUS316
	φ8.0	1.16	φ1.3	—	SUS310S NCF600	SUS316	SUS316	SUS316
Triple Element 	φ4.8	0.72	φ0.50	—	SUS316	SUS316	SUS316	SUS316
	φ6.4	0.93	φ0.72	—	SUS310S NCF600	SUS316	SUS316	SUS316
	φ8.0	1.16	φ0.90	—	SUS310S NCF600	SUS316	SUS316	SUS316

(1) NCF600은 INCONEL 600 에 해당
(2) H2300은 HOSKIN2300®용 특수 시-즈 재입니다.
(3) 표기 이외의 제작도 가능

(1) NCF600 is equivalent to Inconel 600.
(2) H2300 is special sheath material for HOSKINS2300®.
(3) Sheathed thermocouple except shown on the above table are also available.

HOSKINS2300® は Hoskins Manufacturing Co. 미국의 등록상표입니다.

Maximum Length and Approx. Mass of AEROPAK

AEROPAK 시-즈 열전대의 최대제작 길이 개산질량

Sheath O.D. 시-즈 외경	φ0.25	φ0.5	φ1.0	φ1.6	φ3.2	φ4.8	φ6.4	φ8.0
Sheath Maximum Length 시-즈 제작최대길이	138	95	420	185	130	142	80	50
Approx. Mass 개산질량 (g/m)	0.3	1.2	5	10	45	100	180	280

Thermocouple Tolerance and Applicable Standards

열전대의 허용차와 각국의 적용규격 일람

Standard 규격 / Symbol 종류	JIS C1605-1995 Temp. Range 온도범위	Class	Tolerance 허용차 ℃	Standard 규격 / Symbol 종류	IEC 584-2-1982 Temp. Range 온도범위	Class	Tolerance 허용차 ℃	ASTM E230-1996 Temp. Range 온도범위	Class	Tolerance 허용차 ℃
SN & SK	-40℃~+375℃	1	±1.5	N & K	-40℃~+375℃	1	±1.5	0℃~+1260℃	STD.	±2.2 or ±0.75 %
	+375℃~+1000℃		±0.004|t|		+375℃~+1000℃		±0.004|t|			
	-40℃~+333℃	2	±2.5		-40℃~+333℃	2	±2.5		SP.	±1.1 or ±0.4 %
	+333℃~+1200℃		±0.0075|t|		+333℃~+1200℃		±0.0075|t|			
	-167℃~+40℃	3	±2.5		-167℃~+40℃	3	±2.5	-200℃~0℃	STD.	±2.2 or ±2 %
	-200℃~-167℃		±0.015|t|		-200℃~-167℃		±0.015|t|			
SE	-40℃~+375℃	1	±1.5	E	-40℃~+375℃	1	±1.5	0℃~+870℃	STD.	±1.7 or ±0.5 %
	+375℃~+800℃		±0.004|t|		+375℃~+800℃		±0.004|t|			
	-40℃~+333℃	2	±2.5		-40℃~+333℃	2	±2.5		SP.	±1 or ±0.4 %
	+333℃~+900℃		±0.0075|t|		+333℃~+900℃		±0.0075|t|			
	-167℃~+40℃	3	±2.5		-167℃~+40℃	3	±2.5	-200℃~0℃	STD.	±1.7 or ±1 %
	-200℃~-167℃		±0.015|t|		-200℃~-167℃		±0.015|t|			
SJ	-40℃~+375℃	1	±1.5	J	-40℃~+375℃	1	±1.5	0℃~+760℃	STD.	±2.2 or ±0.75 %
	+375℃~+750℃		±0.004|t|		+375℃~+750℃		±0.004|t|			
	-40℃~+333℃	2	±2.5		-40℃~+333℃	2	±2.5		SP.	±1.1 or ±0.4 %
	+333℃~+750℃		±0.0075|t|		+333℃~+750℃		±0.0075|t|			
ST	-40℃~+125℃	1	±0.5	T	-40℃~+125℃	1	±0.5	0℃~+370℃	STD.	±1 or ±0.75 %
	+125℃~+350℃		±0.004|t|		+125℃~+350℃		±0.004|t|			
	-40℃~+133℃	2	±1.0		-40℃~+133℃	2	±1.0		SP.	±0.5 or ±0.4 %
	+133℃~+350℃		±0.0075|t|		+133℃~+350℃		±0.0075|t|			
	-67℃~+40℃	3	±1.0		-67℃~+40℃	3	±1.0	-200℃~0℃	STD.	±1 or ±1.5 %,
	-200℃~-67℃		±0.015|t|		-200℃~-67℃		±0.015|t|			

(1) 허용차란 열기전력을 표준열기 전력표에 의해서 환산한 온도에서 측온접점의 온도를 뺀 값의 허용되는 최대한도를 말 한다.

(2) ASTM의 허용차는 ℃ 또는 측정온도의 %중 큰쪽으로 한다.

(3) [t]는 +,- 부호에 무관한 온도(℃)로 나타내는 측정온도.

(4) Class 1,2,3.은 옛 JIS0.4, 0.75, 1.5급에 대응함.

(5) JIS, BN, DIN 규격은 IEC 규격과 동일함.

(6) ASTM 규격은 옛 ANSI 규격임.

(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 °C or % value for the measured temperature, whichever is greater.

(3) Itl means measuring temperature indicated with the temperature (°C) having no connection with the positive or negative mark.

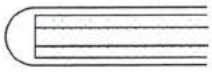
(4) Classes 1, 2, 3 correspond to former JIS Classes 0.4, 0.75, 1.5 respectively.

(5) JIS, BS, DIN standards are same as IEC standard.

(6) ASTM standard is former ANSI standard.

Type of Measuring Junction

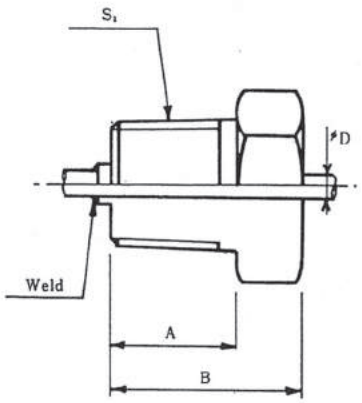
측온접점의 종류

Symbol 기 호	Type 종 류	Shape 형 태	Feature 특 징	Applicable sheath outer diameter 적용 사-즈 외경 (mm)		
				Single	Double	Tripple
G (#8)	접지형 Grounded type		1.약 350MPa 이상의 내압에 가능. 2. 전자유도장해가 있는 장소는 부적당. 1. This type can withstand 350MPa or more. 2. It is not suitable for location with electromagnetic induction on radio frquency inter-ference.	φ0.5~ φ8.0	φ3.2~ φ8.0	φ4.8~ φ8.0
U (#9)	비접지형 Ungrounded type		1. 접지형보다 감도가 늦고 측정대상이 제한 되는것이 없음 2. 소선이 절연물로 덮여있어 장수명. 1. This type has a slower responce than the grounded type but is more commonly used since it is not restricted by the object to be measured. 2. The element is covered with an insulator thereby ensuring a long life span.	φ0.25~ φ8.0	φ3.2~ φ8.0	φ4.8~ φ8.0
U (#5)	비접지 분리형 Ungrounded separate type		1. 2개의 소선을 한곳에 측온점을 설계 지시계, 기록계 등의 분리한 회로에 사용. 2. 특징은 비접지형과 동일. 1. Each pair of double elements is separately used for a measuring junction. This type is used where two function such as indication and control are needed from one thermocouple. 2. The feature is the same as that of the ungrounded type.	–	φ3.2~ φ8.0	φ4.8~ φ8.0
(#6)	노출형 Exposed type		1. 소선이 노출되어 있기 때문에 감도가 빠르다. 2. 엔진의 배기가스등 기체의 온도측정에 적합. 3. 타 온도접점에 비하여 기계적으로 약하다. 1. Since the element is exposed responce time is very fast. 2 .This type is suitable for temperature measurement of gases such as automotive exhaust. 3. This type is mechanically weaker than the other.	φ1.0~ φ8.0	φ3.2~ φ8.0	φ4.8~ φ8.0

Standard Accessories

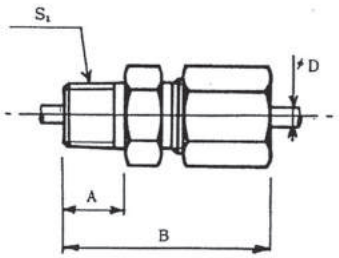
Unit : mm

1. Bushing(fixed) 304S. S.



ϕ D	TYPE	S_1	S_2	A	B
1.0	BN 101	PT⅛	—	10	16
1.6	BN 161	PT⅛	—	10	16
2.2	BN 221	PT⅛	—	10	16
3.2	BN 321	PT⅛	—	10	16
	BN 322	PT¼	—	12	20
	BN 324	PT½	—	20	30
4.8	BN 481	PT⅜	—	10	16
	BN 482	PT¼	—	12	20
	BN 484	PT½	—	20	35
	BN 486	PT¾	—	20	35
6.4	BN 642	PT¼	—	12	20
	BN 644	PT½	—	20	35
	BN 646	PT¾	—	20	35
8.0	BN 802	PT¼	—	12	20
	BN 804	PT½	—	20	35
	BN 806	PT¾	—	20	35

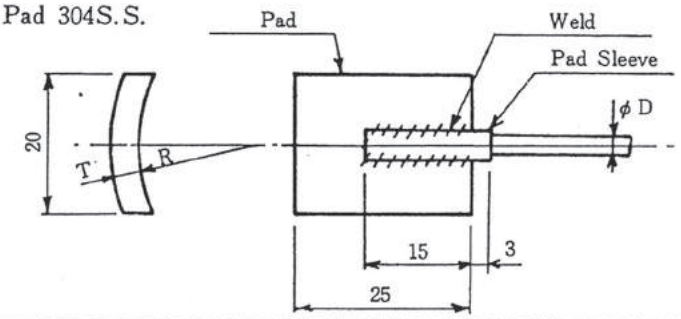
2. Compression Fitting 304S. S.



Note : The cotter in this Fig. is of stainless steel but Teflon cotter (Type. TCF) is also available.

ϕ D	TYPE	S_1	S_2	A	B
1.0	CF 101	PT⅛	—	10	33
1.6	CF 161	PT⅛	—	10	33
	CF 162	PT¼	—	12	35
2.2	CF 221	PT⅛	—	10	33
	CF 222	PT¼	—	12	35
3.2	CF 321	PT⅛	—	10	33
	CF 322	PT¼	—	12	35
	CF 324	PT½	PT⅛	20	59
	CF 326	PT¾	PT⅛	20	59
4.8	CF 481	PT⅛	—	10	33
	CF 482	PT¼	—	12	35
	CF 484	PT½	PT⅛	20	59
	CF 486	PT¾	PT⅛	20	59
6.4	CF 642	PT¼	—	12	35
	CF 644	PT½	PT¼	20	59
	CF 646	PT¾	PT¼	20	59
8.0	CF 802	PT¼	—	12	35
	CF 804	PT½	PT¼	20	59
	CF 806	PT¾	PT¼	20	59

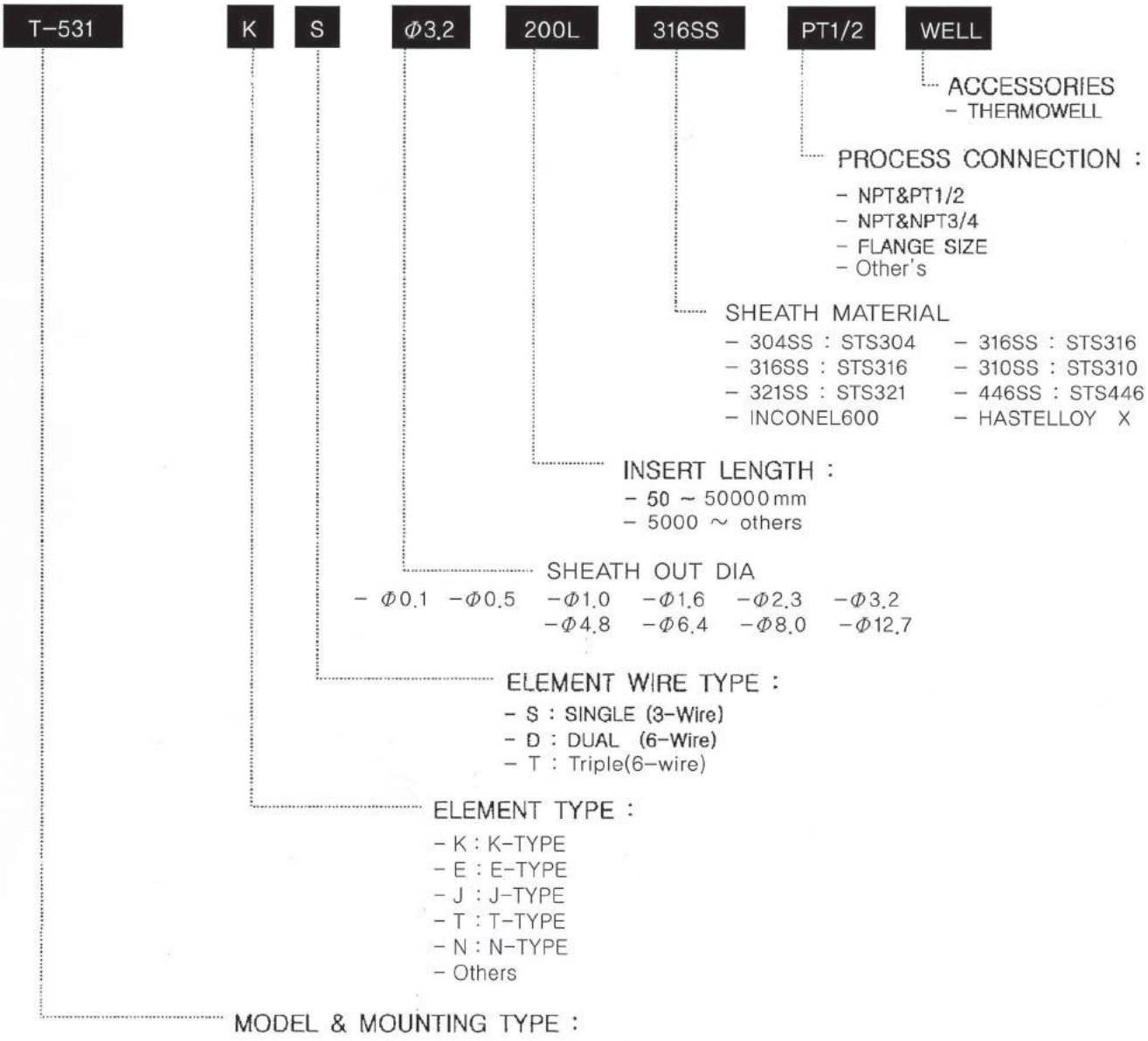
4. Pad 304S. S.



ϕ D	T
3.2	4
4.8	5

Note: Specify "R" when ordering. However, in case R≧50mm, it will be made as "flat."

ORDERING INFORMATION

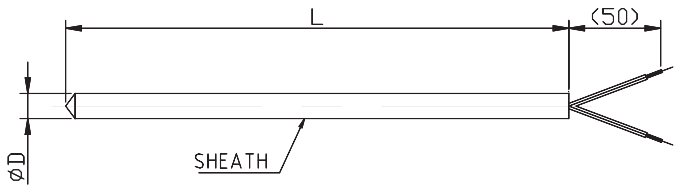
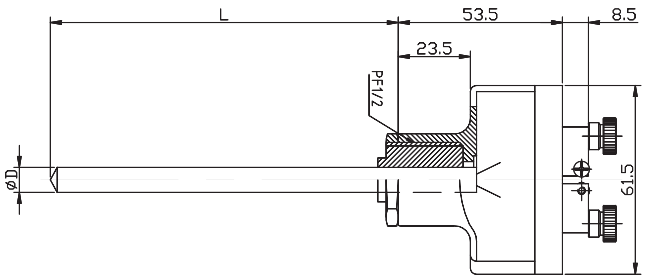
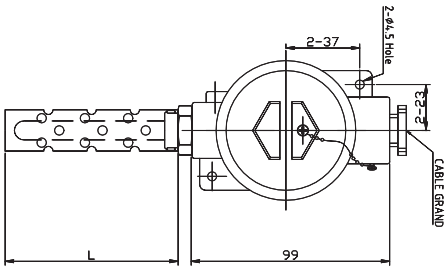
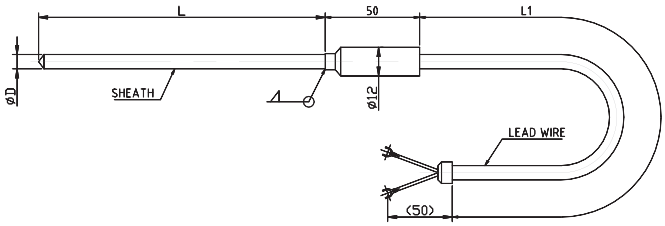
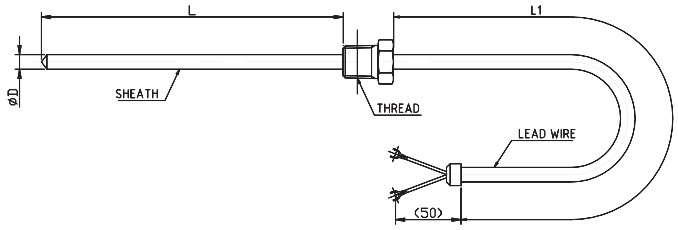
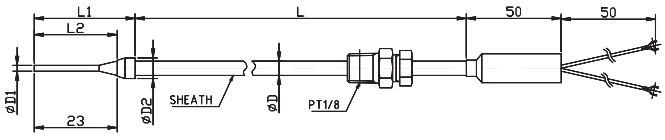
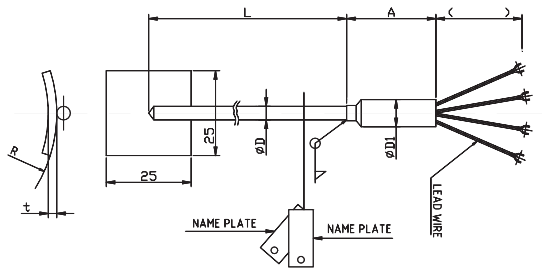
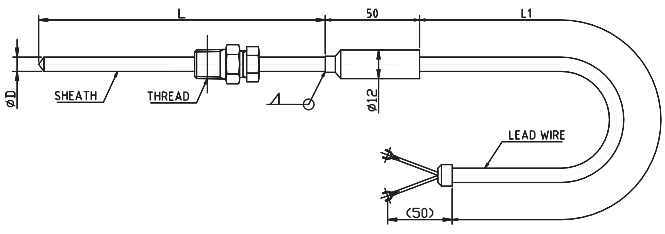
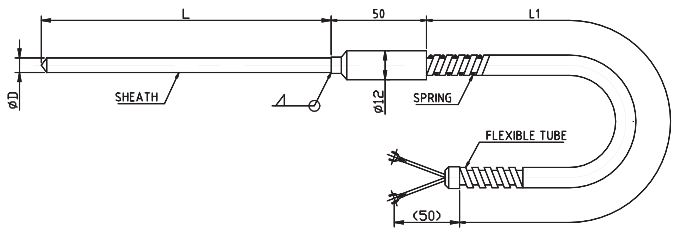
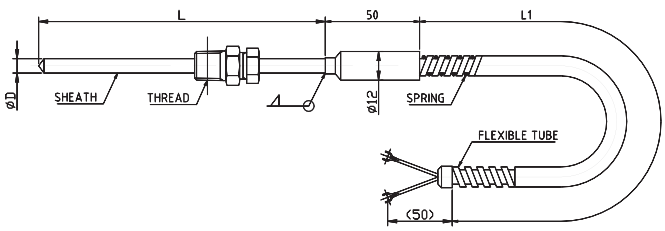


Explosion Proof Type(Ex d IIC T6 IP67)

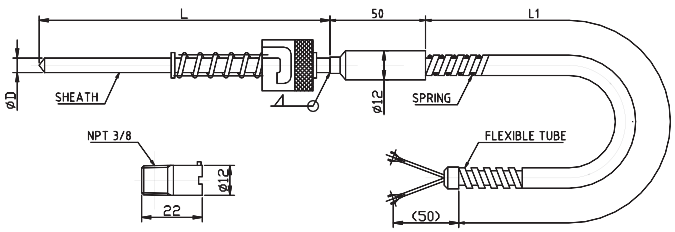
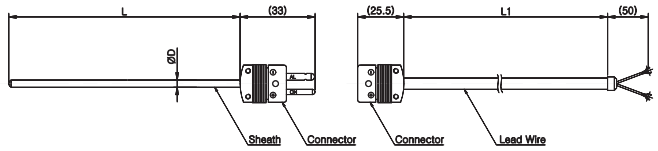
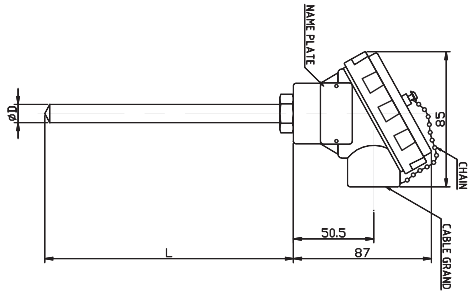
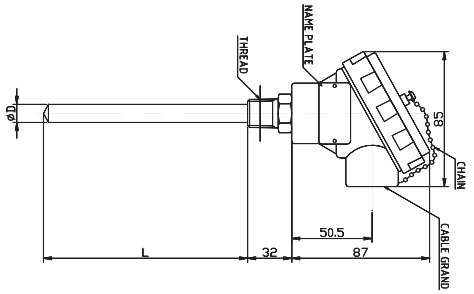
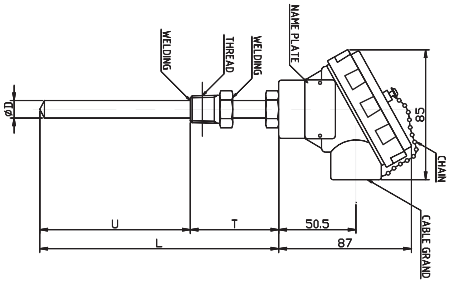
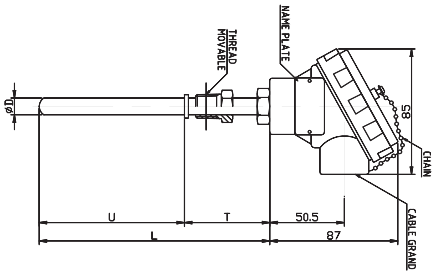
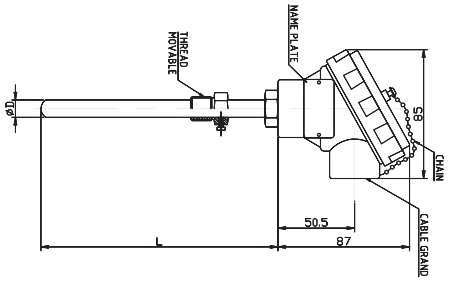
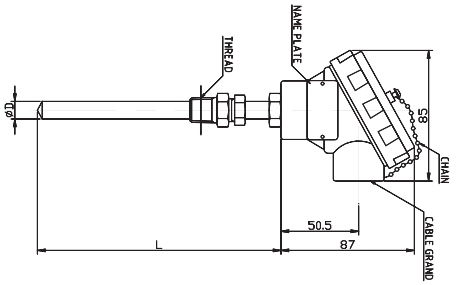
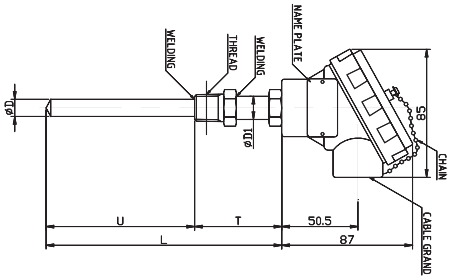
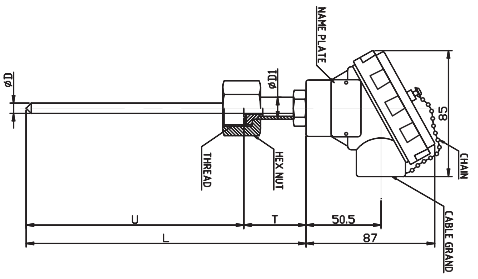
OZT-5**(Temperature Sensor)

- 1 : None
  2 : Thread(PT/NPT)
  3 : Welding Thread & Support Tube
  4 : Thread & Support Tube
  5 : Support Union
  6 : Flange & Support Tube
  9 : Flexible Tube
- 2 : Tube Type
  4 : Sheath Type

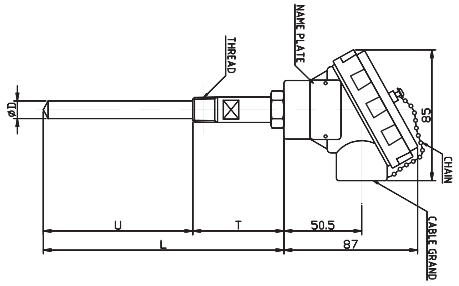
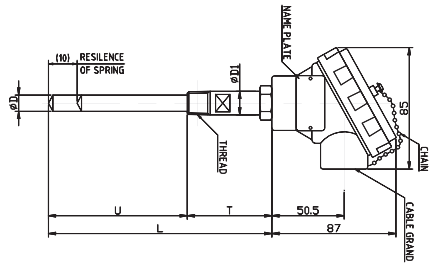
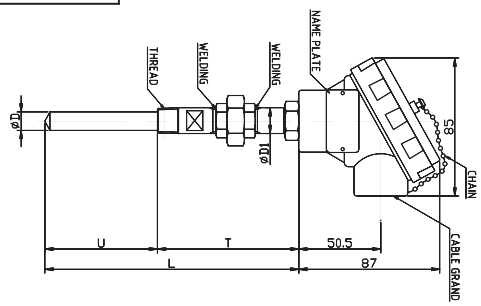
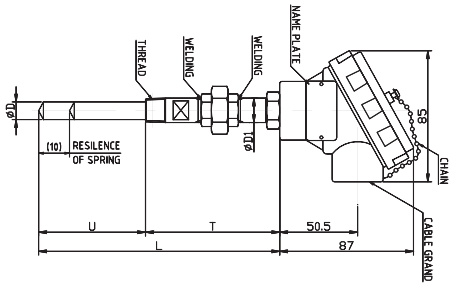
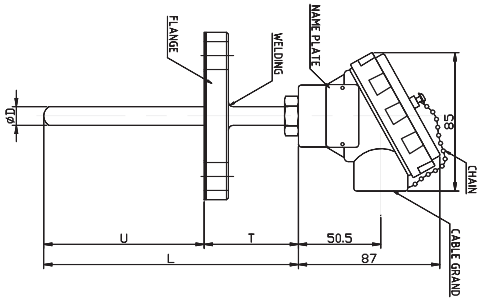
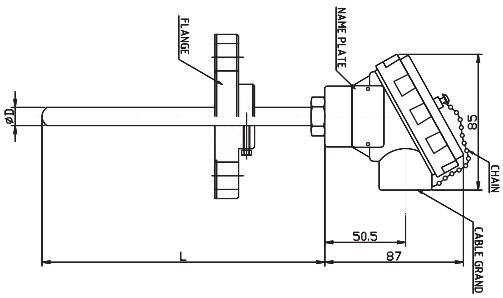
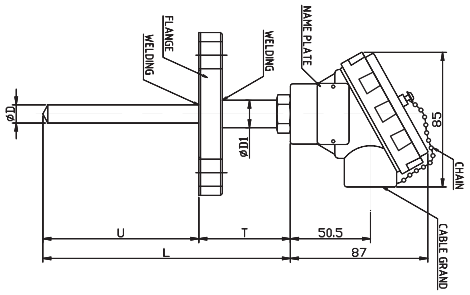
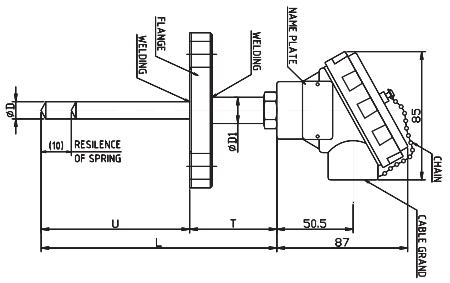
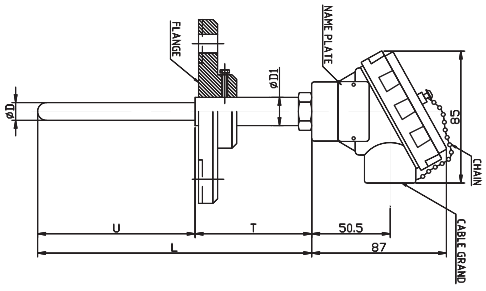
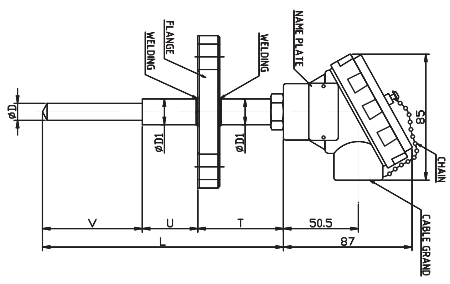
시-즈 열전대 SHEATH THERMOCOUPLE

Basic Model 기본형식	page	Appearance Shape 외관형태	Basic Model 기본형식	page	Appearance Shape 외관형태
T-530A			T-530B		
T-530C			T-530D		
T-530D-1			T-530D-2		
T-530DF			T-530DT		
T-530E			T-530ET		

시-즈 열전대 SHEATH THERMOCOUPLE

Basic Model 기본형식	page	Appearance Shape 외관형태	Basic Model 기본형식	page	Appearance Shape 외관형태
T-530F			T-530G		
T-531			T-532		
T-532A			T-532B		
T-532C			T-532D		
T-533			T-533A		

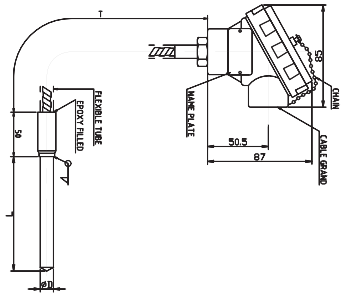
시-즈 열전대 SHEATH THERMOCOUPLE

Basic Model 기본형식	page	Appearance Shape 외관형태	Basic Model 기본형식	page	Appearance Shape 외관형태
T-534A			T-534A-1		
T-534B			T-534B-1		
T-535			T-535A		
T-536			T-536A		
T-536B			T-536C		

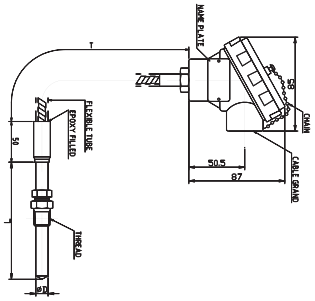
시-즈 열전대 SHEATH THERMOCOUPLE

Basic Model 기본형식	page	Appearance Shape 외관형태	Basic Model 기본형식	page	Appearance Shape 외관형태

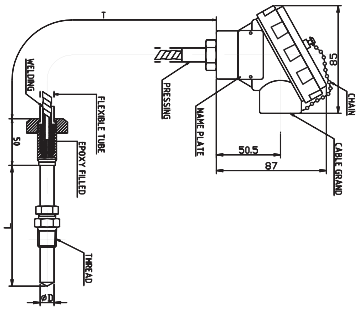
T-539



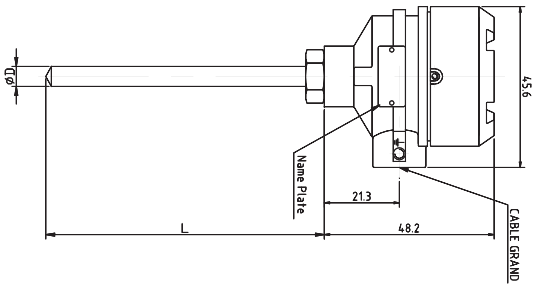
T-539A



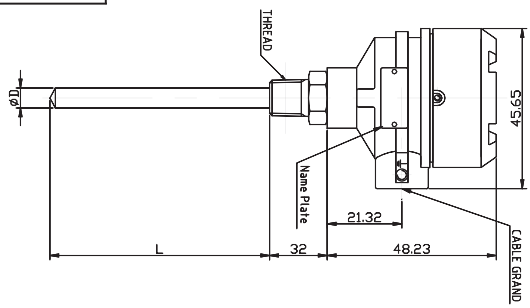
T-539B



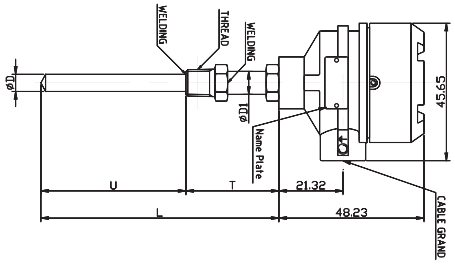
OZT-541



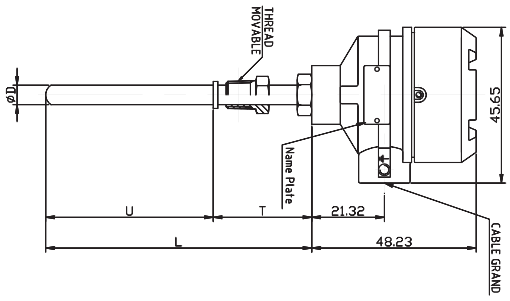
OZT-542



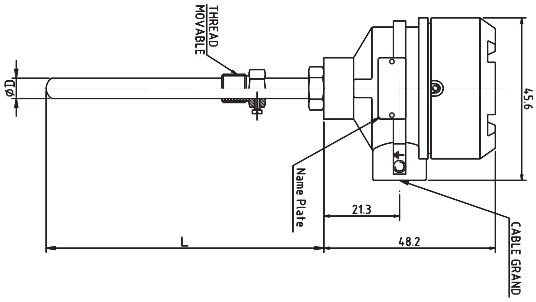
T-542A



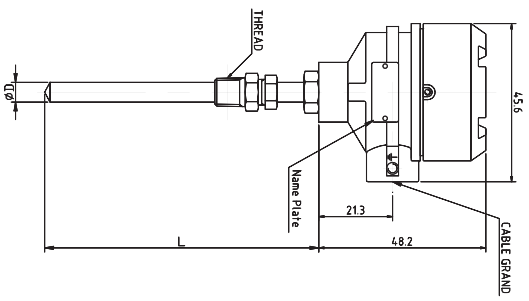
T-542B



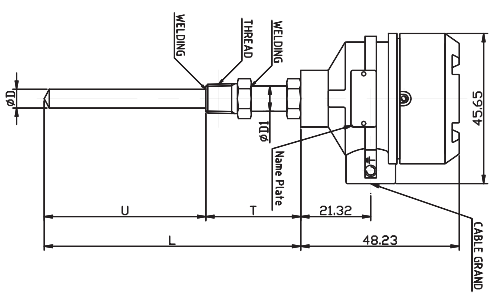
T-542C



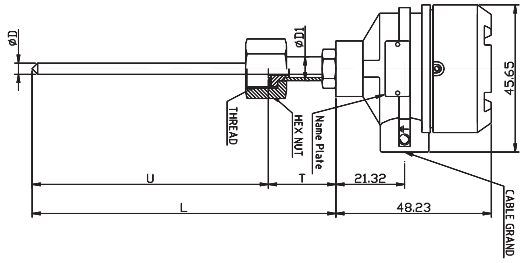
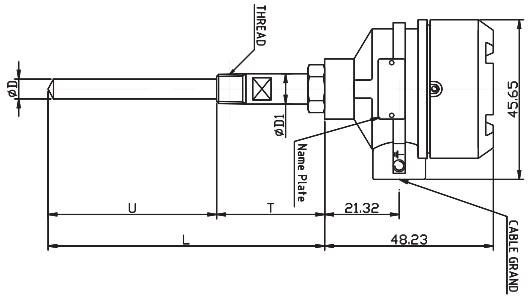
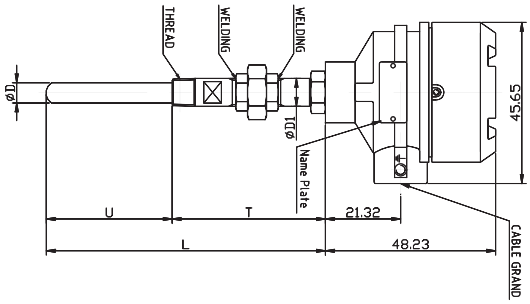
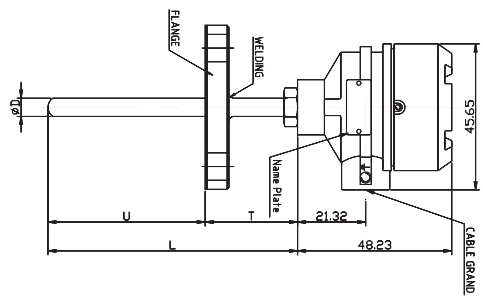
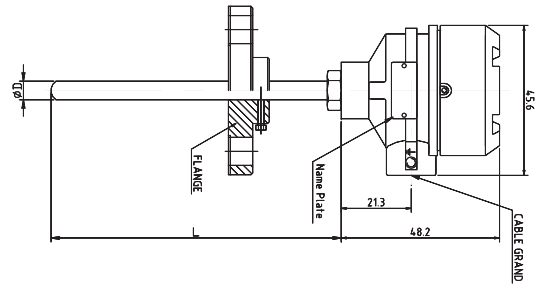
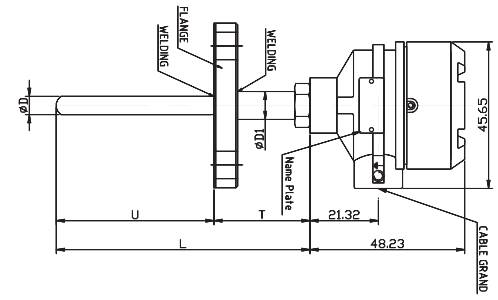
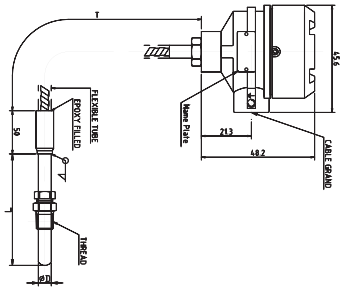
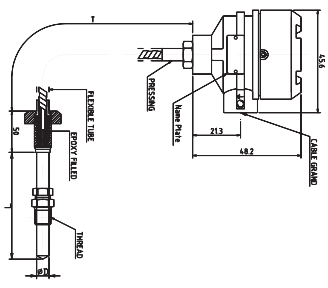
T-542D



OZT-543



시-즈 열전대 SHEATH THERMOCOUPLE

Basic Model 기본형식	page	Appearance Shape 외관형태	Basic Model 기본형식	page	Appearance Shape 외관형태
T-543A			OZT-544		
OZT-545			T-545		
T-545A			OZT-546		
OZT-549			T-549A		
T-549C