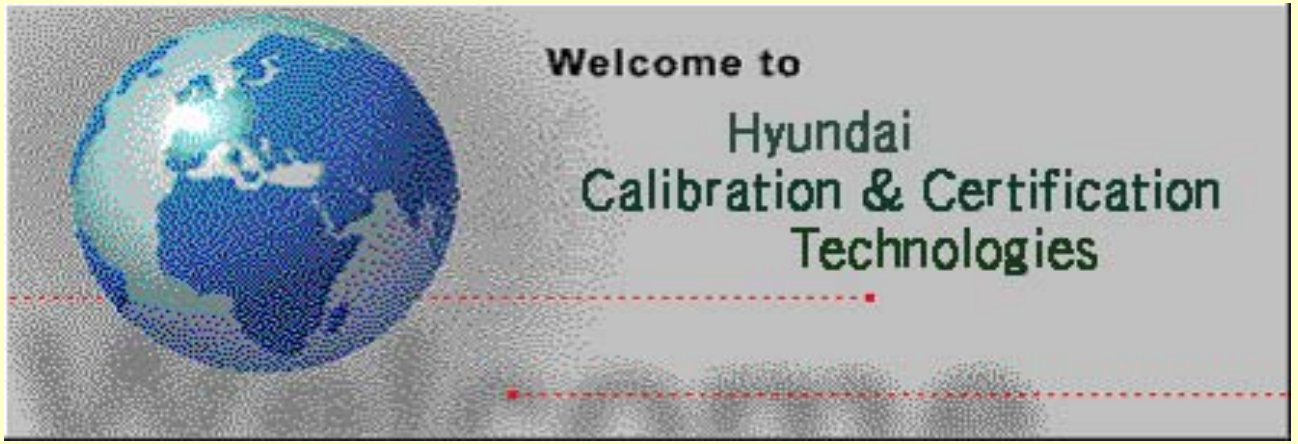
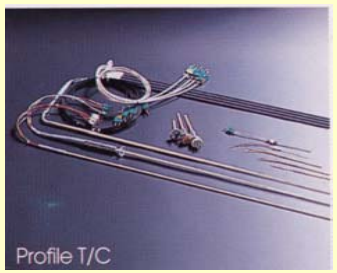
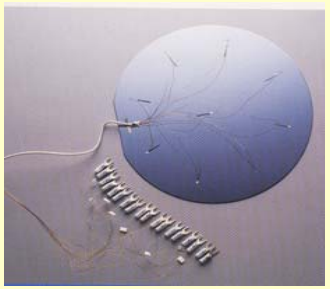


Our Customers' standards are world best



Profile T/C



Wafer T/C

Sheath T/C

RTD

HYUNDAI C-TECH
Hyundai Calibration & Certification Technologies Co., Ltd.

Company Scope

Hyundai C-Tech is operating as a full scale subcontractor of Hyundai Electronics, one of the worlds best semiconductor manufactures.

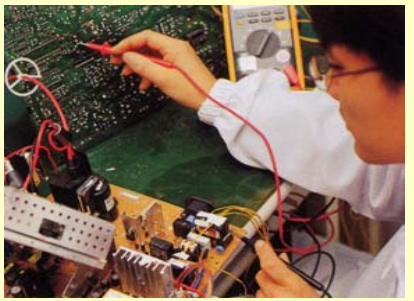
. Sensors : Fabrication, calibration and repair (Precise/Industrial)

. Calibration/repair : Measuring, testing and inspection equipment (electrical/physical…)

. Regulatory type approval: International (export to the world), Domestic (import to Korea)

Sensor Fabrication

Photo Density Calibration



Monitor Safety Test

Company History

.1985 • 1996 National Calibration Lab.Accredited for 26 calibration fields

.1987 • 1996 International Testing Lab.Accredited for EMC

(By 14 certification bodies of 8 countries:UL,FCC,TUV ---)

.Nov.1993 Gold award in National Precise Measurement Promotion Contest

.Feb.1994 Thermocouple development for semiconductor equipments completed

.Nov.1996 Grand Prix from the president of Korea in National Quality Contest

.Mar.1999 Wafer thermocouple development completed

.Jun .2000 Hyundai C-Tech founded independently from Hyundai Electronics

.Aug.2000 National type approval testing Lab.Accredited from Korean Ministry of information & Communication for all its 5 accreditation fields

.Oct.2000 National Calibration Lab.accredited under KOLAS Scheme.a sub-scheme of ILAC/APLAC MRA Scheme

Company Certification

.Lab. Accreditation

.Calibration & Repair : National Calibration Lab accredited for 26 cal. Fields under KOLAS Scheme. A sub-scheme of ILAC/APLAC MRA Scheme

.EMC : Accredited by 5 International Certification Bodies(FCC -------)

.MPR-Ⅱ : Accredited by 2 International Certification Bodies(TuV-PS -------)

.Safety : Accredited by 8 International Certification Bodies(UL,TuV,CSA-------)

.Ergonomics : Accredited by TuV-PS,TuV-RH.

What is a Thermocouple?

.Features of Thermocouple

Industrial thermocouple, in comparison with other thermometers, have the following features

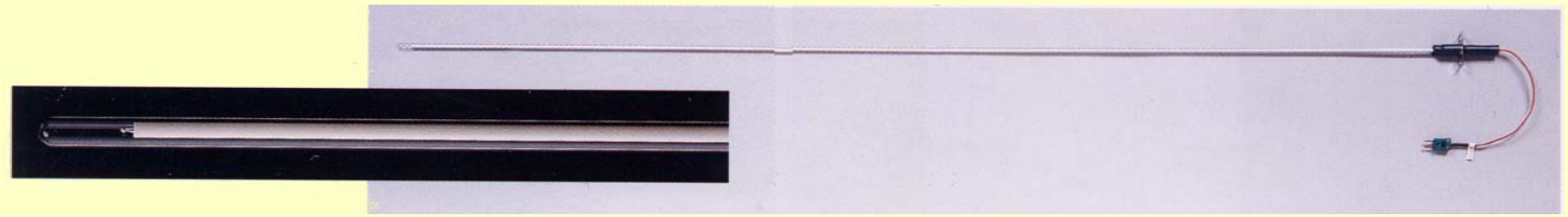
1.Quick response and comparatively small time-lag

2.If appropriate selection of a quality thermocouple is made, a wide range of temperature from absolute 0 to 2300 ℃ can be measured.

3.Temperature of specific spot or small space can be measured

4.Since temperature is detected by means of EMF, measurement, adjustment, amplification, control, conversion and other processing are easy

5.Less expensive and easily available in comparison with other temperature sensors



Thermocouple for a Semiconductor fabrication equipment

.Structure and Measuring Method

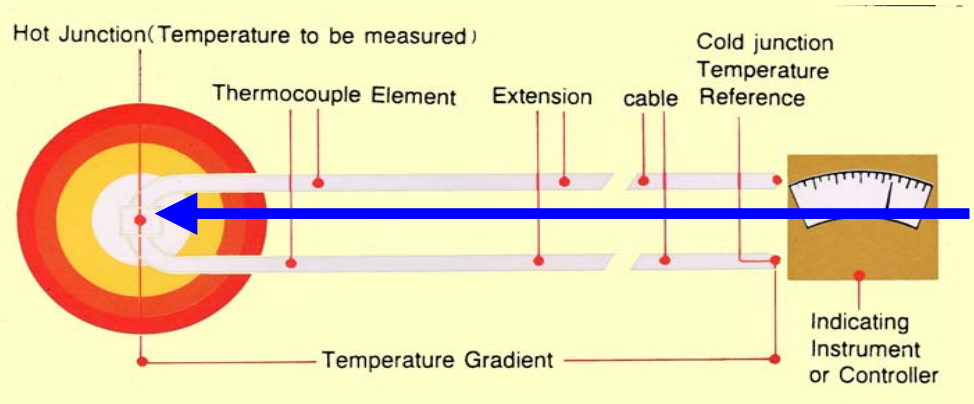
Generally,industrial thermocouples are inserted into an insulating tubes to prevent short circuits between the element wires. They are then inserted into a protective tube so as not to contact directly the object or surrounding atmosphere.

Reference junction is compensated at a certain temperature(mostly at 0 ℃) for measurement.

The EMF so generated is measured by means of moving coil type,electronic type,auto balancing type ,potentiometric or other indicating instruments.

.Precaution in practical Applications

Since there are various types of thermocouples, it is most important to select the appropriate thermocouple for the specific application. In addition,care should be given to the selection of protection tube,structure and fitting method With due consideration of resistance to heat,corrosion and vibration.



HYUNDAI C-TECH
Hyundai Calibration & Certification Technologies Co., Ltd.

Type of Thermocouples

1.Noble Metal Thermocouple

TYPE	Combination of Element Wires	
	Positive(+) Leg	Negative(-) Leg
B	70 % Platinum.30 % Rhodium	94 % Platinum.6 % Rhodium
R	87 % Platinum.13 % Rhodium	100 % Platinum
S	90 % Platinum.10 % Rhodium	100 % Platinum

2.Base Metal Thermocouple

TYPE	Combination of Element Wires	
	Positive(+) Leg	Negative(-) Leg
K	Chromel	Alumel
E	Chromel	Constantan
J	Iron	Constantan
T	Copper	Constantan
N	Nicrosil	Nisil

3.Special Thermocouple

TYPE	Combination of Element Wires	
	Positive(+) Leg	Negative(-) Leg
HA	Tungsten	Tungsten.26 % Rhenium
HB	Tungsten.3 % Rhenium	Tungsten.25 % Rhenium
HC	Tungsten.5 % Rhenium	Tungsten.26 % Rhenium
NUCLEAR	Platinum,5 % Moly	Platinum,0.1 % Moly
PLATINEL	55 % Palladium,3 % Platinum,14 % Gold	35 % Palladium,65 % Gold
IRA	Iridium	Iridium,40 % Rhodium
IRB	Platinum , 40 % Rhodium	Iridium,40 % Rhodium
AuFe	Au,Annealed 0.07 Fe	Chromel

Characteristics of Thermocouples

.B Type(Pt.30 %Rh/Pt.6 %Rh) Thermocouple 0 ℃ • 1,700 ℃

Type B thermocouple has higher melting point and mechanical strength than other Pt/Rh thermocouples because of its Higher content of Rhodium. Type B thermocouple can be used continuously in oxidizing and neutral atmospheres up to 1,600 ℃ and,even in reducing atmosphere,can be used for longer period than other Pt/Rh thermocouples.
Type B thermocouple is recommended especially for the applications requiring precision measurement and durability at high temperature.

.R Type(Pt.13 %Rh/Pt) Thermocouple 0 ℃ • 1,600 ℃

Type R thermocouple is recommended for use in oxidizing and inert atmosphere at temperature, up to 1,400 ℃ and Intermittently up to 1,600 ℃ .However,it should not be used in vacuum,reducing or metallic vapor atmospheres unless Properly protected with ceramic insulating and protection tubes.

.S Type(Pt.10 %Rh/Pt.) Thermocouple 0 ℃ • 1,600 ℃

Type S thermocouple is historical thermocouple originally developed by Le Chayelier in 1886.It is widely used as a Standard thermometer to determine the fixed(freezing) points ranging from 630.74 ℃ for Antimony to 1,064.43 ℃ For Gold as defined by the international Practical Temperature Scale(IPTS).Applications similar to type R.

.K Type(Chromel/Alumel) Thermocouple -20 ℃ • 1,250 ℃

Type K thermocouple is now most widely used as industrial thermocouple with high reliability because of its versatile characteristics.It can be used in oxidizing or inert atmospheres at temperature up to 1,260 ℃ .Type K Thermocouple may be used in hydrogen or cracked ammonia atmospheres if the dew point is below –42 ℃. However,it should not be used in reducing,sulfurous or “green-rot” corrosive atmospheres unless properly protected.

.E Type(Chromel/Constantan) Thermocouple -200 ℃ • 900 ℃

Type E thermocouple has the highest EMF characteristics among industrial thermocouples.Since it was adopted by ANSI in 1964,type E thermocouple has met rapidly increasing demands and has been widely used even in large scale thermal and nuclear power stations.It can be used up to 750 ℃ continuously.

For practical use,precautions similar to those for type K are required.Careful attention is also required in selection of the indicator to be connected because type E thermocouple has the highest resistively among the base metal thermocouples.

.J Type(Iron/Constanta) Thermocouple 0 ℃ • 750 ℃

Type J thermocouple has the second highest characteristics next to type E,and E is recommended for the use in reducing inert,oxidizing or vacuum atmospheres up to 750 ℃.Because of comparatively less expensive price,type J has been easily accepted for the use in various applications.However,it should not be used in sulfurous above 528 ℃ Under these atmospheres,the iron element is often rusted so that type J is less desirable than type T for low temperature measurement..

.T Type(Copper/Constantan) Thermocouple -200 ℃ • 350 ℃

Type T thermocouple has good resistance to corrosion in moist atmospheres and is suitable for sub-zero temperature measurements.It can be used in vacuum and in oxidizing,reducing or inert atmospheres up 370 ℃.
Because of its stable and precise EMF characteristics,type T is widely used in laboratories.Type T is the first thermocouple for which tolerance in the sub-zero temperature range has been established..

.N Type(Nicrosil/Nisil) Thermocouple 0 ℃ • 1,300 ℃

Type N thermocouple,new thermocouple combination of 84Ni-14.2Cr-1.4Si v.s 99.5Ni-4.4Si-0.1Mg,exhibits long term stability and oxidation resistance over type K when used at high temperature ranging from 600 to 1,250 ℃.
By virtue of fine adjustment of chromium content with additions of Si and Mg,it has less E.M.F shift.

.H/Re Thermocouple

There are three kinds of Tungsten/Rhenium thermocouple,and it can be used for super high temperature up to 2,760 ℃.

.Nuclear(Pt.5%Mo/Pt.0.1%Mo) Thermocouple

This thermocouple is suitable to be used in He atmosphere of atomic reactor,be cooled by gas,and can be used up to 1,400 750 ℃.

.Platinel Thermocouple

It is a kind of noble metal thermocouple.The EMF characteristic is similar to type K.be used up to 1,400 750 ℃.

Precautions and Considerations for Using Thermocouples

Most measurement problems and errors with thermocouples are due to a lack of understanding of how thermocouples work. Listed below are some of the more common problems and pitfalls to be aware of.

. Connection problems.

Many measurement errors are caused by unintentional thermocouple junctions. Remember that any junction of two different metals will cause a junction. If you need to increase the length of the leads from your thermocouple, you must use the correct type of thermocouple extension wire (eg type K for type K thermocouples). Using any other type of wire will introduce a thermocouple junction. Any connectors used must be made of the correct thermocouple material and correct polarity must be observed.

. Lead Resistance

To minimize thermal shunting and improve response times, thermocouples are made of thin wire (in the case of platinum types cost is also a consideration). This can cause the thermocouple to have a high resistance which can make it sensitive to noise and can also cause errors due to the input impedance of the measuring instrument.

. Decalibration

Decalibration is the process of unintentionally altering the makeup of thermocouple wire. The usual cause is the diffusion of atmospheric particles into the metal at the extremes of operating temperature. Another cause is impurities and chemicals from the insulation diffusing into the thermocouple wire. If operating at high temperatures, check the specifications of the probe insulation

. Noise

The output from a thermocouple is a small signal, so it is prone to electrical noise pick up. Most measuring instruments reject any common mode noise (signals that are the same on both wires) so noise can be minimized by twisting the cable together to help ensure both wires pick up the same noise signal. If operating in an extremely noisy environment, (such as near a large motor) it is worthwhile considering using a screened extension cable. If noise pickup is suspected first switch off all suspect equipment and see if the reading changes.

. Common Mode Voltage

Although thermocouple signal are very small, much larger voltages often exist at the input to the measuring instrument. These voltages can be caused either by inductive pick up (a problem when testing the temperature of motor windings and transformers) or by 'earthed' junctions. A typical example of an 'earthed' junction would be measuring the temperature of a hot water pipe with a non insulated thermocouple. If there are any poor earth connections a few volts may exist between the pipe and the earth of the measuring instrument. These signals are again common mode (the same in both thermocouple wires) so will not cause a problem with most instruments provided they are not too large.

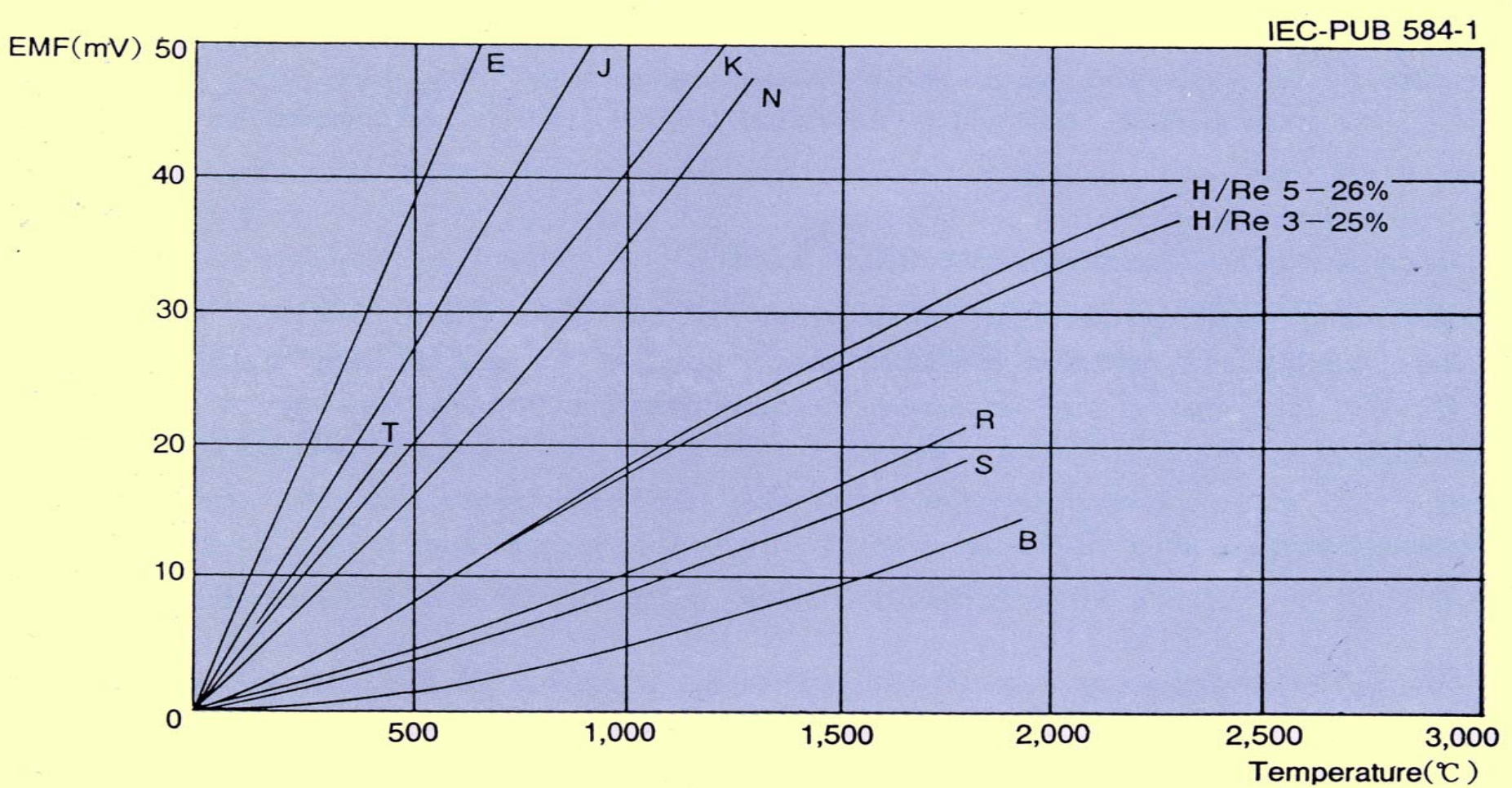
. Thermal Shunting

All thermocouples have some mass. Heating this mass takes energy so will affect the temperature you are trying to measure. Consider for example measuring the temperature of liquid in a test tube: there are two potential problems. The first is that heat energy will travel up the thermocouple wire and dissipate to the atmosphere so reducing the temperature of the liquid around the wires. A similar problem can occur if the thermocouple is not sufficiently immersed in the liquid, due to the cooler ambient air temperature on the wires, thermal conduction may cause the thermocouple junction to be a different temperature to the liquid itself. In the above example a thermocouple with thinner wires may help, as it will cause a steeper gradient of temperature along the thermocouple wire at the junction between the liquid and ambient air. If thermocouples with thin wires are used, consideration must be paid to lead resistance. The use of a thermocouple with thin wires connected to much thicker thermocouple extension wire often offers the best compromise.

Tolerance for Temperature Reading

Type	Temperature Range	Class	Tolerance
B	600 ℃ • 1,700 ℃	0.5	± 4 ℃ or ± 0.5 % of Reading
R S	0 ℃ • 1,600 ℃	0.25	± 1.5 ℃ or ± 0.25 % of Reading
K	0 ℃ • 1,000 ℃	0.4	± 1.5 ℃ or ± 0.4 % of Reading
	0 ℃ • 1,200 ℃	0.75	± 2.5 ℃ or ± 0.75 % of Reading
	-200 ℃ • 0 ℃	1.5	± 2.5 ℃ or ± 1.5 % of Reading
E	0 ℃ • 800 ℃	0.4	± 1.5 ℃ or ± 0.4 % of Reading
	0 ℃ • 800 ℃	0.75	± 2.5 ℃ or ± 0.75 % of Reading
	-200 ℃ • 0 ℃	1.5	± 2.5 ℃ or ± 1.5 % of Reading
J	0 ℃ • 750 ℃	0.4	± 1.5 ℃ or ± 0.4 % of Reading
	0 ℃ • 750 ℃	0.75	± 2.5 ℃ or ± 0.75 % of Reading
T	0 ℃ • 350 ℃	0.4	± 0.5 ℃ or ± 0.4 % of Reading
	0 ℃ • 350 ℃	0.75	± 1 ℃ or ± 0.75 % of Reading
	-200 ℃ • 0 ℃	1.5	± 1 ℃ or ± 1.5 % of Reading
N	0 ℃ • 1,250 ℃	0.75	± 2.5 ℃ or ± 0.75 % of Reading

EMF Chart for Typical Thermocouple



Operating and Maximum Temperature Limits

Type	Wire Dia(mm)	Operating Temp Limits(℃)	Maximum Temp Limits(℃)
B	0.50	1,500	1,700
R	0.50	1,400	1,600
S	0.50	1,400	1,600
K	0.65	650	850
	1.00	750	950
	1.60	850	1,050
	2.30	900	1,100
	3.20	1,000	1,200
E	0.65	450	500
	1.00	500	550
	1.60	550	650
	2.30	600	750
	3.20	700	800
J	0.65	400	500
	1.00	450	550
	1.60	500	650
	2.30	550	750
	3.20	600	750

Type	Wire Dia(mm)	Operating Temp Limits(℃)	Maximum Temp Limits(℃)
T	0.32	200	250
	0.65	200	250
	1.00	250	300
	1.60	300	350
N	1.60	900	1,100
	2.30	1,100	1,200
	3.20	1.200	1,300
HB	0.50	2,300	2,800
HC	0.50	2,300	2,800
PLATINEL	0.50	1,200	1,300
NUCLEAR	0.01	1,600	1,650
IRA		2,000	2,100

Thermocouple Color Codes

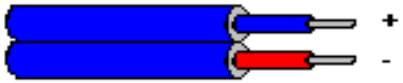
Thermocouple wiring is color coded by thermocouple types. Different countries utilize different color coding. Jacket coloring is sometimes a colored stripe instead of a solid color as shown.

United States ASTM

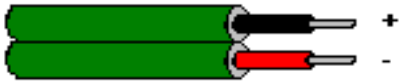
J

K

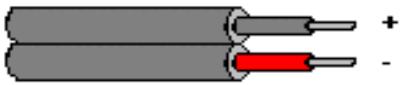
T



R/S



B



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All kinds of thermocouple sensors, wafer type thermocouple sensor,

sheath thermocouple sensors, RTD sensor

We can tailor-make thermocouple sensors to cater to the requirements of individual customers.

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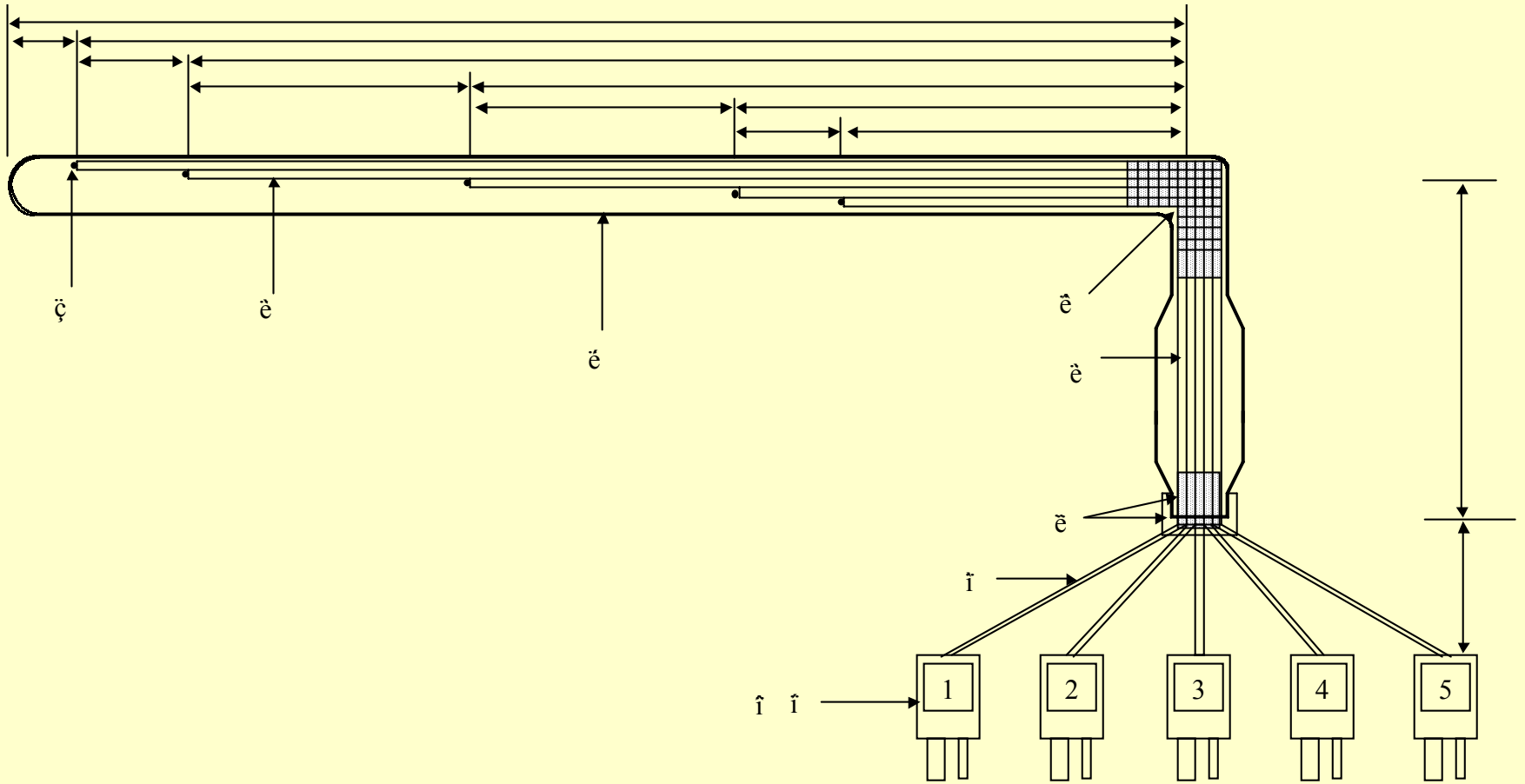
High temperature platinum resistance thermometer,Au/Pt thermocouple,

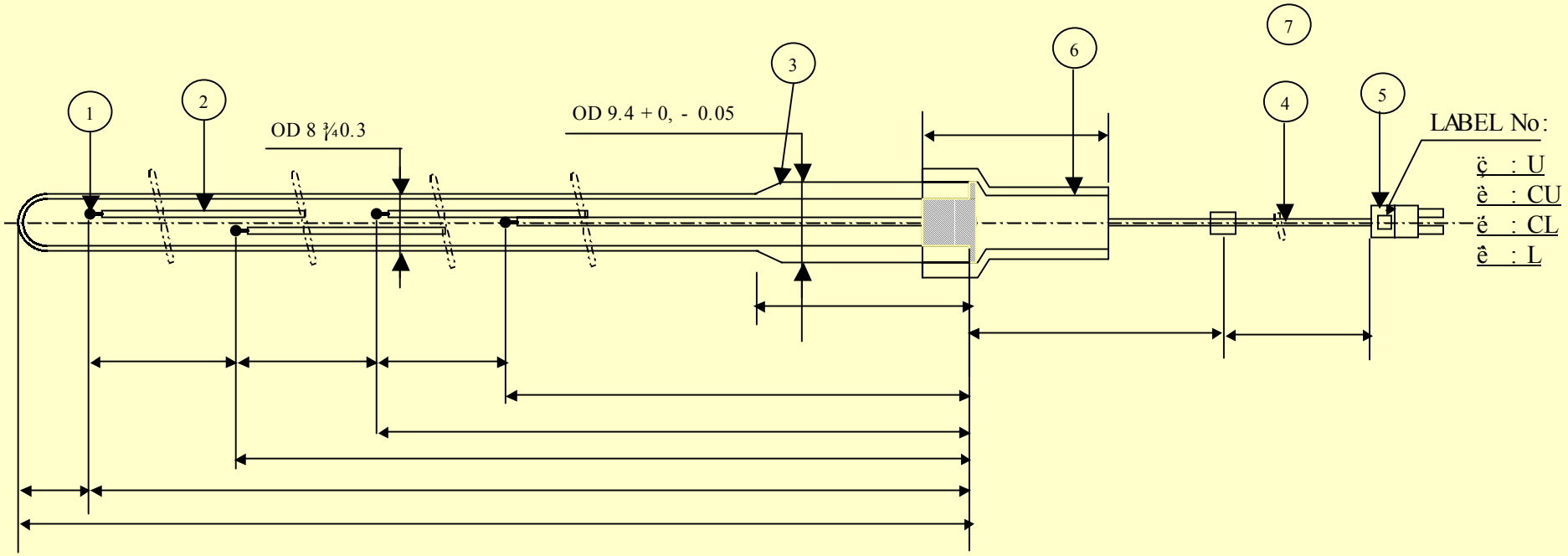
Wafer type RTD sensor

We are also performing research on developing new sensors.

THERMOCOUPLE(HCT-TEL 808 CVD)



THERMOCOUPLE(HCT-DJ-815V-8BL-D)



NO	PART	PART NAME	MODEL	SPECIFICATION
ç	TCWX-002	WIRE	R-TYPE	OD 0.5mm
è	TCIX-001	INSULATOR	OVAL-2 HOLE	3.0*1.85*0.8*1800
ë	TCPX-022	PROTECTION TUBE	823 REF/6	9.5*8*1425
ê	TCCX-006	CONNECTOR	R-TYPE	PLUG, LARGE(marin)
ē	TCWX-008	CABLE	Comp	1mm
ì	TCOX-002	OTHERS	WIRE CLAMP	LARGE, MARINE ¾
í	TCTX-018	SHRINK TUBE	SILICON TUBE-È é	11.0*1.5T
î	TCTX-028	SHRINK TUBE	Normal TUBE-RED	OD 3mm

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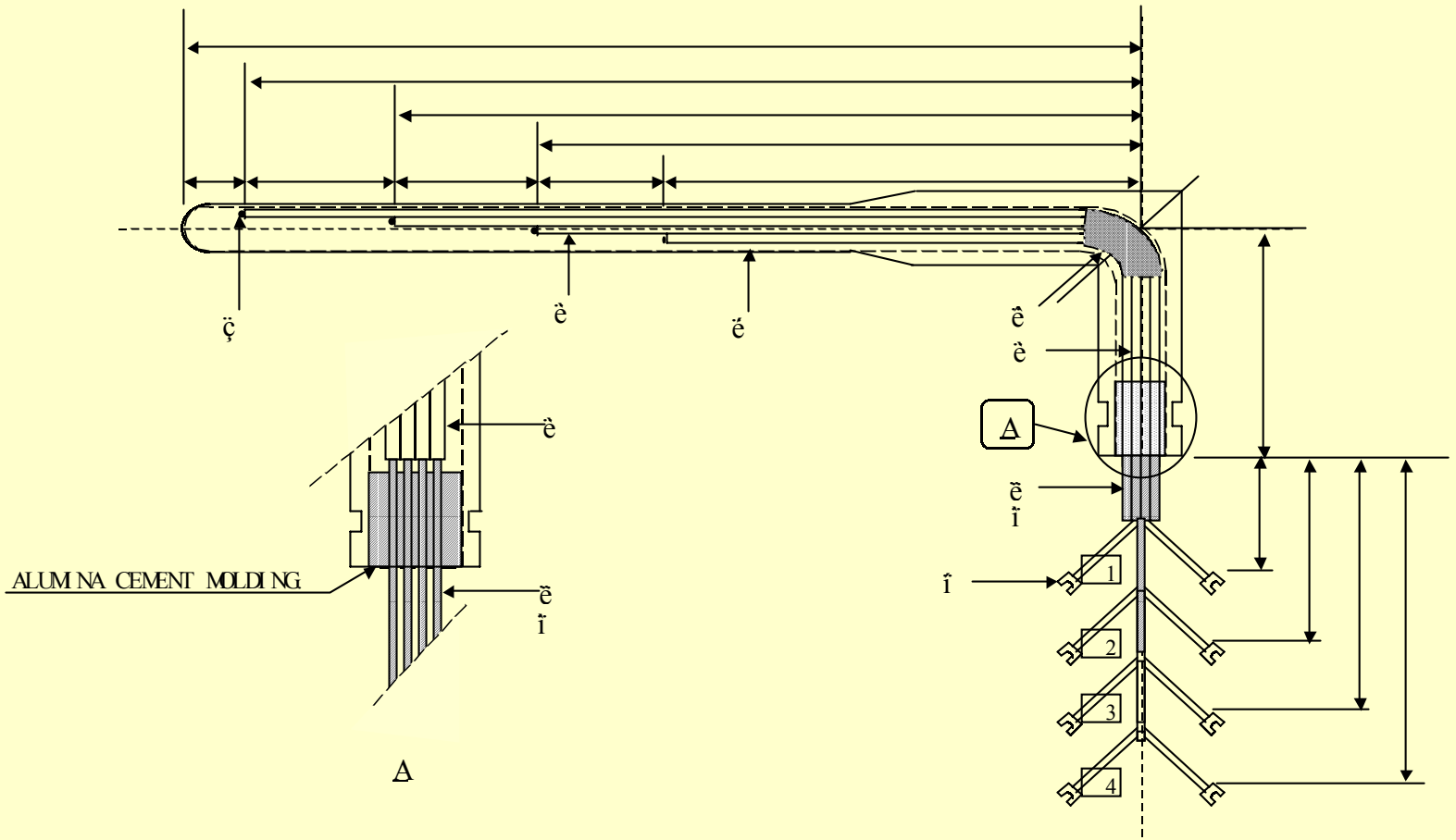
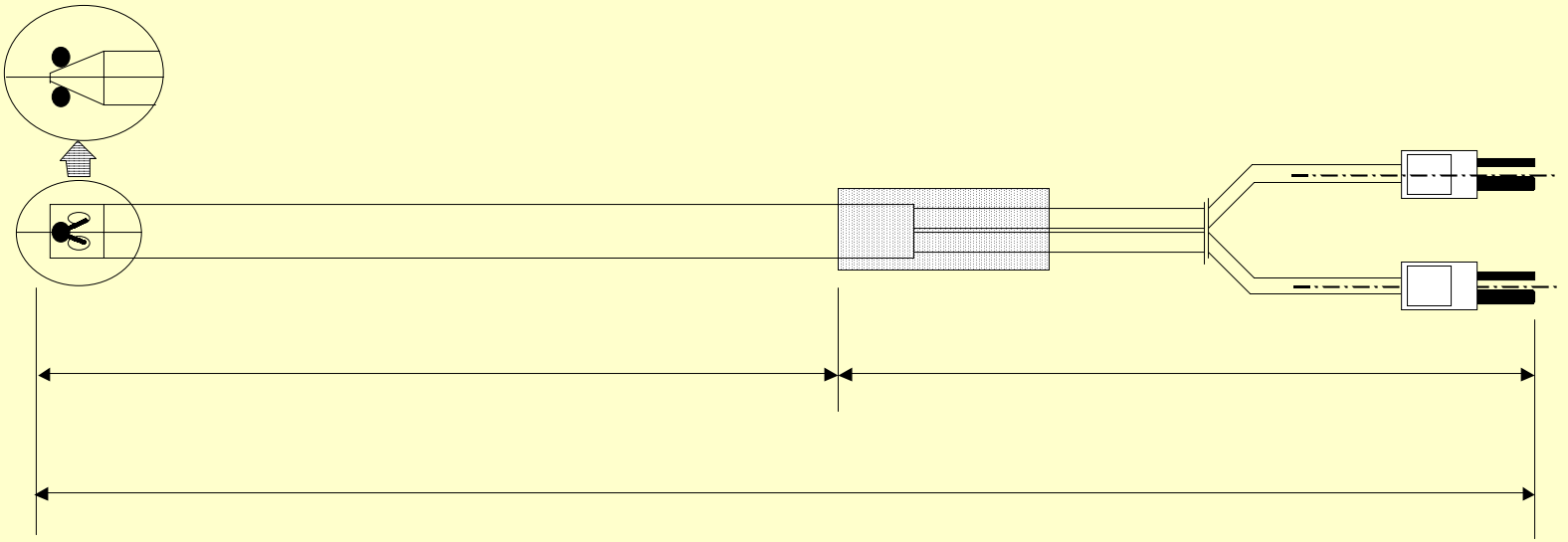
THERMOCOUPLE(HCT-TVF-001)



THERMOCOUPLE(HCT-TEVBX-R08)



NO.	PART NO.	SPECIFICATION
①	TCW-002	0.5 mm
②	TCI-011	4*0.8*400
③	TCT-015	OD 5mm
④	TCT-001	1*0.8, RED
⑤	TCT-002	1*0.8, BLACK
⑥	TCC-006	PLUG, SMALL(marin)

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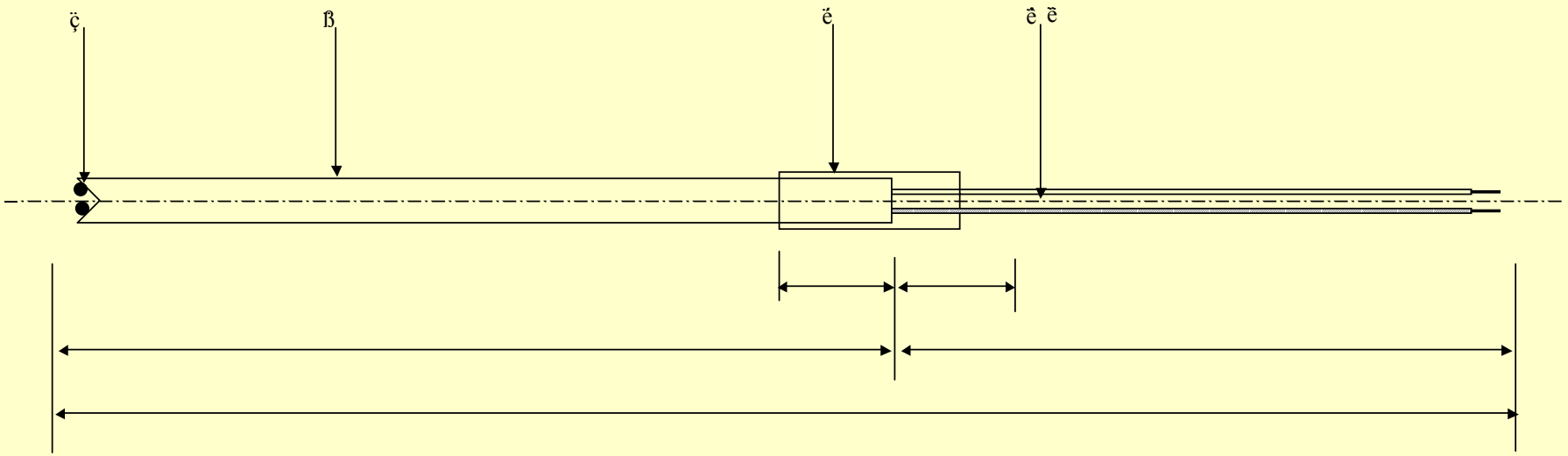
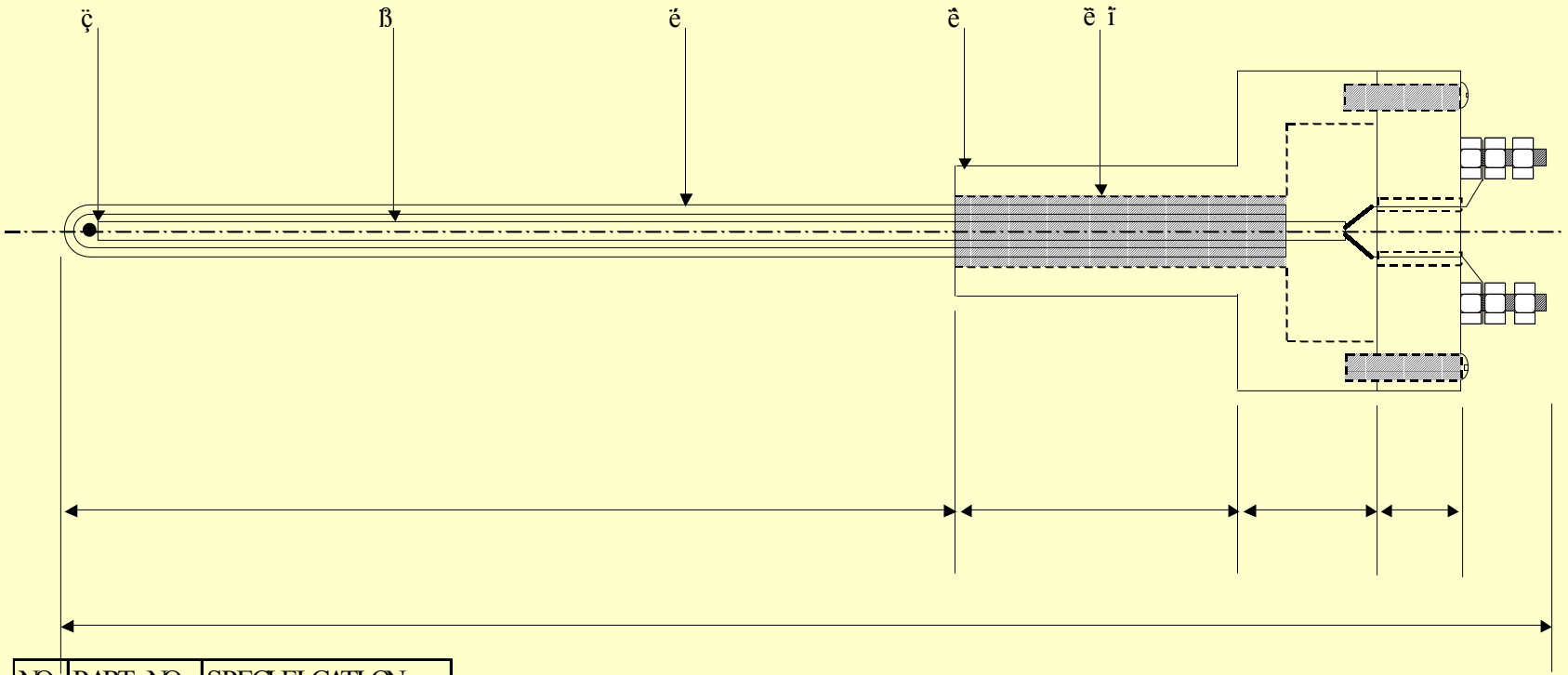
THERMOCOUPLE(HCT-TEVBX-606)



NO.	PART NO.	SPECIFICATION
ç	TCW-002	OD 5mm
è	TCI-011	4*0.8*400
ë	TCT-020	OD 5mm
ê	TCT-001	1*0.8, RED
ẽ	TCT-002	1*0.8, BLACK

THERMOCOUPLE(HCT-KEVHX-601)



NO	PART NO	SPECIFICATION
ç	TCW-002	OD 5mm
è	TCI-012	1.5*0.6*150
ë	TCP-018	AL 203
ê	TCF-006	SUS 316S+AL203
ẽ	TCO-016	®é Ç
ĩ	TCO-017	áÎ ÆÍ ½

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gstephens@stamerica.com

Name: Greg Stephens