

Thermocouple Solutions for the Glass Industry

Our Quality Temperature Sensors Help to Make your Products Better



Proven Products • Proven Performance
Globally positioned • Technology driven • Customer focused

Contents

Thermocouple Types	1
Specifications	2
Fibro® Platinum TC Wire	3
Crown Thermocouple Assemblies	4
Introduction	4
How to order	4
High Performance Dual Sheath Thermocouple	5
Special Design for Fiberglass Production	7
Installation recommendations	8
Components	
Thermocouples for Glass Furnace Bottom	11
Introduction	11
Small Diameter Thermocouples for "in block" Furnace Bottom	13
Traditional Single Sheath Thermocouple for "in block" Furnace Bottom	14
Dual Sheath with a Grain Stabilized Platinum Insert	16
Full Length Sheath Immersion Thermocouple, Standard Strength	16
Full Length Sheath Immersion Enclad [®] Thermocouple, High Strength	
Installation recommendations - Bottom	20
Components	22
Thermocouples for the Forehearth	23
Introduction	23
Specifications	23
Traditional Full Length Tri- Level Thermocouple	25
Traditional Reduced PM Tri- Level Thermocouple	25
Ultra-Low Reduced PM Tri- Level Thermocouple	
Heavy-Duty, High Strength Tri- Level Thermocouple	
High Strength, Long Life PM Tri- Level Thermocouple	27
Reduced PM Tri-Level Thermocouple with Glass Line Protection Sleeve	27
Traditional Reduced PM Simplex Thermocouple	
Components	
Forehearth TC Installation Guide	29

Thermocouple Types

A Thermocouple is a welded joint of two dissimilar metals that generates an electromotive force that is a function of the temperature difference between the welded joint and measurement reference point.

A Thermocouple is a well-known, reliable and relatively inexpensive temperature measuring device. Limited accuracy of measurements is the main drawback of thermocouples. It is very difficult to achieve a ±1 °C tolerance.

When selecting a thermocouple, its type, insulation and design of the probe should be considered since these factors affect the temperature measuring range, accuracy and reliability of measured values and most importantly longevity of the device.

Precious metal thermocouples (Types S, R and B)

Characteristics of these thermocouples are similar. They provide stable readings. However, due to their lower sensitivity (approximately 10µuV/°C), they are only used for high temperature measurements (above 300 °C).

S Type: Pt vs. Pt 10% Rh

This is one of the most popular and widely used thermocouple types based on a combination of precious metals. It is known for high accuracy in a wide range of temperatures. It has excellent mechanical and chemical properties, and low electrical resistivity. It is also most commonly used as a calibration standard when evaluating Types B, R and S.

Recommended temperature range

400°C - 1400°C	continuously
400°C - 1700°C	intermittently
Environment	
Oxidizing	Preferred
Neutral	Acceptable
Reducing	Not recommended
Vacuum	Application dependent

Availability

All sized down to 0.5mm (~0.020") diameter (smaller diameters can be custom-made).

Tolerances

There are 2 levels of conformity: Reference and Standard Grade. Special tolerance thermocouples can be provided on demand.

R type: Pt vs Pt 13% Rh

This is one of the most popular and widely used thermocouple types based on a combination of precious metals. It is known for high accuracy in a wide range of temperatures. It has excellent mechanical and chemical properties and, low electrical resistivity.

Recommended temperature range

400°C - 1400°C	continuously
400°C - 1700°C	intermittently
Environment	
Oxidizing	Preferred
Neutral	Acceptable
Reducing	Not recommended
Vacuum	Application dependent

Availability

All sized down to 0.5mm (~0.020") diameter (smaller diameters can be custom-made).

Tolerances

There are 2 levels of conformity: Reference and Standard Grade. Special tolerance thermocouples can be provided on demand.

B type: Pt 6%Rh vs Pt 30%Rh

This widely used thermocouple is very similar to other combinations of Pt and Rh. This thermocouple type has demonstrated to perform better than types "S" or "R" at higher temperatures. Types "S" and "R" quickly start to produce output errors and can physically break down at the higher temperatures. Another unique feature of type "B" is that, at reference junction temperatures below 100°C, it usually does not require a compensating cable; bare copper wire is sufficient.

Recommended temperature range

800°C - 1600°C	continuously
800°C - 1770°C	intermittently
Medium	
Oxidizing	Preferred
Neutral	Acceptable
Reducing	Not recommended
Vacuum	Application dependent

Availability

All sized down to 0.5mm (~0.020") diameter (smaller diameters can be custom-made).

Tolerances

There are 2 levels of conformity: Reference and Standard Grade. Special tolerance thermocouples can be provided on demand.

Specifications

Ceramics

All BASF produced thermocouples for the glass industry are fabricated with high purity alumina insulation. The alumina content is at a minimum of 99.7%. While it is commonly known that high purity alumina is needed for stable performance of precious metal thermocouples used at high temperatures, it must be realized that type and nature of the remaining impurities are equally important. BASF choses its high purity alumina with great emphasis on eliminating known deleterious contaminants such as Fe, Ni, Cr, Sb, among others. Equally as important in the selection process are the concentrations of certain glass formers and combinations of them such as B₂O₃, SiO₂.

Thermocouple Wire

The wire used in all thermocouples is matched and calibrated to comply with ISA, ANSI, or IEC reference tables to a minimum accuracy of +/- 0.25%, of temperature range from 400°C to 1450°C. All thermocouples supplied on a single order are fabricated from a single batch of wire insuring that all thermocouples have a uniform accuracy. Lot calibration, as well as specific unit calibrations data can be supplied at an additional cost.

Fibro[®] Platinum TC Wire

Some thermocouple designs use Fibro[®] Platinum with types R&S. Fibro[®] wire is produced via a proprietary wire making process which imparts an elongated grain structure to the metal. This structure, in addition to strengthening the wire, imposes barriers to the migration of contamination and subsequent weakening of the material. Fibro[®] wire provides additional stability of calibration and increases the thermocouples effective life.



Pt - longitudinal section



Fibro® Pt - longitudinal section



Pt - cross section



Fibro® Pt - cross section

Photo micrograph of 0.032" dia. Fibro[®] Pt wire and Pt wire after being heated to 1400°C for 10 hours. Longitudinal and cross section. Note the reduced grain growth of Fibro Pt (100x reduced 50%).

Scrap Metal Recovery

Precious metal thermocouples always have value even when they are no longer usable. The metal content of glass industry thermocouples can be recycled into new replacements; or, monetary credit can be given to the user with book credit for use at a later date. For the most accurate and beneficial credit, spent thermocouples should be returned intact for disassembly at the plant so that proper material and alloy separation can be performed. Contact the customer service office for specific details on how to return spent thermocouples.

Crown Thermocouple Assemblies

Introduction

Overheating of the crown in a glass melter promotes accelerated refractory corrosion and wear. Operating a crown at too low a temperature, on the other hand, may reduce melting efficiency and increase fuel consumption. Crown thermocouples provide important data on the operating temperature of the melter, regenerator and refiner.

Determination and control of the melter hot spot, essential for effective glass circulation, can be readily achieved by placing a number of crown thermocouples along the center of the arch. A reliable sensor will also provide the necessary data to prevent potentially destructive "over temperature" conditions to occur.

In all gas or oil fired glass melters the crown thermocouple must withstand the highest tank operating temperature. Temperatures of 1500°C to 1600°C are typical. In high alumina or silica glasses, temperatures may exceed 1650°C at the hot spot. For thermocouples to perform dependably great care must be exercised in the selection of materials, particularly with regard to purity, and in their fabrication.

How to order

Each thermocouple has a unique part number. This part number; four digits preceded by "01" — defines the basic design. To this number must be added a code for the wire calibrations and the required dimensions to enable the device to fill the specific application. Please review the Installation Recommendation section before deciding on required dimensions.

Order number



Calibration code

S = Pt - Pt10Rh

R = Pt - Pt13Rh

```
B = Pt6Rh - Pt30Rh
```

Select sizes, quantities, and designs of crown thermocouples are kept in stock, to provide rapid response to field replacement needs and short turn-around time during rebuilds. The following designs and sizes are generally available, but this is naturally subject to previous demand:

Model number	Calibration	L₁ (in inches)	L ₂ (in inches)
01-6010 and 01-6020 R, S, B		20, 28, 32	4
	18, 30, 36, 42	6	
01-6015 and 01-6025 R, S, B		20, 32	4
	Г, О , D	18, 30	6
01-6040 and 01-6050		20, 28, 32	4
	К, О, Б	12, 18, 24, 30	6

Note: 1 inch = 25.4 mm.

Note: When duplex thermocouples are ordered, it is possible to locate the junctions on the same or different location from the tip. In the latter case, please consult with customer service.



High Performance Dual Sheath Thermocouple

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

Dual sheath designs provide the optimum protection for the thermocouple In the event of outer sheath fractures or erosion, the inner sheath continues to provide extended protection. Fibro[®] Pt wire is used on types R and S for optimum performance.

This design has become the standard in the industry. Campaign life in float and container plants is not unusual. Recorded test data on many installations has demonstrated that calibration after 7 years of service is within 25°F of the original calibration tolerance.

Number	Characteristic
01-6010-Cal-L1-L2	Simplex, with 0.032" dia. wire
01-6020-Cal-L ₁ -L ₂	Duplex, with 0.032" dia. wire
01-6015-Cal-L ₁ -L ₂	Simplex, with 0.020" dia. wire
01-6025-Cal-L ₁ -L ₂	Duplex, with 0.020" dia. wire

Traditional Single Sheath Crown Thermocouple



When ordering, please specify the full number of the thermocouple: Model Number- calibration code - dimensions L1-L2.

Options

This heavy wire, single sheath design has been used for many years in applications which require the additional wire diameter to provide acceptable life. High purity ceramics provide the required environment for added performance.

Number	Description
01-6040-Cal-L ₁ -L ₂	Simplex, with 0.032" dia. wire
01-6045-Cal-L ₁ -L ₂	Duplex, with 0.032" dia. wire



Traditional Single Sheath Low Cost Crown Thermocouple

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

This design is intentionally used for general applications in which maximum economy is imperative. The combination of high purity components and meticulous attention to assembly details provide an economical balance between service and cost.

Number	Description	
01-6050-Cal-L1-L2	Simplex, with Ø 0.020" wire	
01-6060-Cal-L1-L2	Duplex, with Ø 0.020" wire	

Small Diameter Crown Thermocouple



When ordering, please specify the full number of the thermocouple: Design code - calibration code - dimensions L1-L2.

Options

Small diameter sheaths are sometimes required either to fit between refractory bricks or to accommodate originally designed installations. This design incorporates the identical care in material selection, manufacture, and assembly as the large diameter models, and can be expected to provide equivalent service.

Number	Description	
01-6070-Cal-L ₁ -L ₂	Simplex with slip fit insulation	
01-6080-Cal-L ₁ -L ₂	Enclad [®] option which provides protection to corrosion caused by the furnace batch dust	



Special Design for Fiberglass Production

When ordering, please specify the full number of the thermocouple: Design code - calibration code - dimensions L1-L2.

Variants

The batch chemistry used in the production of aluminaborosilicate glasses, generally found in insulation or filament glass, is extremely corrosive for traditional thermocouples. To resist this corrosion, in order to achieve optimum reliability, a precious metal sheath is required. This design utilizes BASF's Enclad[®] technology and has been very popular for this application with campaign life performance reported.

Number	Characteristic
01-6090-Cal-L ₁ -L ₂	Simplex, Enclad [®] version
01-6095-Cal-L ₁ -L ₂	Duplex, Enclad [®] version
01-6100-Cal-L ₁ -L ₂	Simplex Conventional design, 0.032" dia. wire
01-6105-Cal-L ₁ -L ₂	Duplex Conventional design, 0.032" dia. wire

Installation recommendations

Many reports of short life or poor performance of crown thermocouples can be traced back to improper installation. The following sketches show typical errors made in the field as well as some recommended practices. BASF is always pleased to consult with you on your installation and design details. Please feel free to call your nearest sales/service center for assistance.

Application Notes

The following guidelines, drawn from our many years' experience of serving the glass industry, will help achieve the best performance from crown thermocouples.

Whether crown thermocouples are immersed into the atmosphere or mounted in dead end blocks, the following recommendations apply.

Installation:

- Blind holes should be cleaned out to ensure that no foreign matter is present. Some early failures have been noted due to attack by nuts and bolts; excess batch; or low grade ceramic cement being inadvertently left in the block from the installation stage.
- 2. Pack the entrance hole through which the thermocouple is mounted to prevent hot gas "sting out." Hot gas cutting off the ceramic and overheating of the head are thereby prevented. Thermocouples mounted in dead-end blocks should still be packed in preparation for eventual block wear or cracking which will subject the assembly to the "chimney effect".
- 3. Atmosphere thermocouples should not be immersed more than 2 inches. The rate of attack by batch dust carry-over and resulting corrosion increases significantly at greater insertion lengths.
- 4. The head/connection box should be extended 6 to 10 inches above the crown or insulation blanket to insure that reasonable head temperatures are maintained at the connection point of the extension lead wire. Overheating of the terminals is a major cause of open circuit signals as well as of erratic readings. In addition, when the temperature of the connection point between the thermocouple and extension wire exceeds 200°C the compensation factor begins to deteriorate causing reading errors of up to 25°C. Incidentally, it is generally found to be easier to attach lead wires prior to installing the thermocouple.
- 5. Experience has shown that plug and jack connector terminations, as opposed to a sealed-head, may be plagued with corrosion or poor contact problems.
- 6. Thermocouple assemblies should be fully supported by a stable mounting arrangement. Tripods, flanges, or split standoffs are effective if properly installed.

Example of incorrect installation



Thermocouple sized improperly so that head rests on crown surface. Overheating of head and corrosion of terminal contacts is certain after a few months. Large reading errors are probable, due to excessive temperature at the connection point between the thermocouple and extension wire. Most extension wire is rated to approximately 200°C for reasonable compliance with electrical properties and retention of insulation integrity.



Improved and recommended practice

Whether dead-ended or into-the-atmosphere, the thermocouple should be supported by an external arrangement, with the head 6" to 10" minimum above the refractory. The entrance hole must be sealed with packing material or gout to prevent chimney effect (string out) corrosion.

Below are two examples of proper installation showing alternative methods of weight support. Packing is essential.

Improved and recommended practice



It is another example of correct installation showing an alternative support method. Packing here is crucial.

Components

Tripod



This 300 series stainless steel tripod securely supports all thermocouples. The thermocouple is fixed at any height by tightening two 5/16 inch bolts on the mounting tube.

Ordering Information

Part No. : 00-8030

Standard mounting flange



A stainless steel flange with three adjustable screws conveniently supports a crown thermocouple.

Ordering Information

Specify

Part No. : 00-8010-01

Compensating extension wire



Information for Field Installation

Specify

00-6100 - calibration code - length (L) in feet (6 feet is recommended, 1 foot = 304.8mm). Note:

For flexible stainless steel protective cover.

Specify

00-6105 - calibration code - length (L) in feet.

Adding compensating extension cables with preassembled electric wiring facilitates crown thermocouple installation. It is easier to replace and check devices, if a plug connector is located at some distance from the furnace crown. The lead wire is impregnated high-temperature glass, with a glass braid jacket. A mating connector, and strain relief clamp is provided for convenient connection into the thermocouple head.

Note:

The compensating extension wire can be ordered as part of the full thermocouple assembly.

Specify the thermocouple code and the number of the extension wire.

Example

"Thermocouple 01-6010-S-24-6 with the connected wire 00-6100-S-6" means a dual sheath crown thermocouple with the 6 feet long extension wire terminated with a plug and jack.

Thermocouples for Glass Furnace Bottom

Introduction

The BASF line of Glass Melter / Refiner Thermocouple Assemblies represent the cumulative benefit of more than 80 years of dedicated design and assembly service to the glass industry. The care and attention to detail in material selection, processing, and assembling, have been developed and established with campaign life as a goal while maintaining EMF stability and reliable performance as a prerequisite.

Bottom melter thermocouples play an important role in the efficient operation of a glass tank. It has been shown that for each 1.3°C lowering of bottom temperature, a typical furnace will save approximately 1% in energy consumption. To control the melt process so that lower bottom temperatures can be achieved, while maintaining proper circulation and throat flow demands a high level of reliability in the sensor. In addition, throat flow monitoring, especially gradient temperature determination, is useful if the sensors are stable.

One innovation introduced by BASF that has resulted in more stable performance is Enclad[®].

Application Notes

The following guidelines are drawn from many years of observation and experience. Evaluating these comments in light of your specific applications may prove beneficial in providing optimum life and performance from melter thermocouples.

Glass composition

Life and stability of in-glass thermocouples, when properly designed and installed are generally excellent for all traditional **soda-lime** and borosilicate glass compositions. All of the soda-lime glasses, (except amber) found in container and float, as well as any of the fiberglass compositions should pose little threat to the sensor. Such is not the case with leaded, opal, high arsenic and other specialty glass.

High lead glass has a tendency to become unstable during the early melting and refining process and may locally decompose or reduce in the presence of precious metals. It is not fully understood at this time if the catalytic nature of platinum and its alloys contribute to or promote this occurrence. In either case, the lead compounds react with the precious metal causing disintegration of the sheath and ultimate attack of the assembly by the glass constituents. Life expectancy of thermocouples in leaded glass tends to vary with lead content. As an example, 3 to 6 months for 24% Pb is typical, but great variations have been noted to exist. In general, once the glass has been refined and most of the SO₂, CO and CO₂ have been desorbed, compatibility with the precious metal is re-established. This is noted in many applications where forehearth immersion thermocouples perform adequately whereas melter and to a lesser degree refiner units regularly fail. At this juncture, dual sheath assemblies with or without precious metal liners, in dense dead end blocks, is the only practical recommendation that can be made for monitoring or controlling melter temperature. Precious metals are readily attacked by the Halogens. Opal, and other glasses relying on fluorine compounds as a colorant, will destroy immersion assemblies in a short time period. Even low level fluorine bearing glasses have a tendency towards metal attack. The life of thermocouples must be determined for each application. Halogens easily attach to precious metals. Ground and other glass containing fluoric components quickly destruct thermocouple assembles immersed into glass. Even glass with low fluorine content tends to erode metal. That's why the service life of thermocouples should be determined individually for each application.

Flatware and other products relying on arsenic or lithium additives as brightening agents have proven problematic on occasion. While concentrations of the additives are low, upsets in redox potential due to combustion control excursions have been noted to cause local reduction of the element and subsequent destruction of the precious metal.

Amber glass is well documented for its incompatibility with precious metals. The sulphur within the colouring agents combine with the rhodium forming a glassy phase compound which dissolves readily in the soda-lime matrix. The use of GS (Grain Stabilized) Platinum eliminates this occurrence and should be exclusively used in all amber tank applications.

Electrical melting/heating of glass

The performance of platinum alloys in electric melters has been extensively investigated over the past twenty years. The dissolution rate of platinum sheaths and thimbles is known to be proportional to the exposed metal surface area; and the leakage current through the metal to tank ground, and inversely proportional to the frequency of the power mains. Recorded observations compared with theoretical calculations have been in excellent agreement. Leakage currents of 10 amperes has been documented to physically destroy a 2-inch immersion sheath in 120 days.

The prevention and cure of electrolysis failure is relatively simple. Using the following notes as a guide an instrument specialist can easily guard against common problems.

Page 12 Thermocouples for the Glass Industry

A few recommendations can be broadly stated for thermocouple installation, most of which are based on observations and tests conducted in the field.

- Thermocouples must be completely isolated from electrical contact with any tank metal work. 1.
- 2. Support of the sensor should be by use of flanges resting on non-conductive sheets.
- 3. If shielded compensating lead wire is used, the shield should be wrapped with glass tape for that portion which is inside the terminal head. Many inadvertent groundings have been recorded because of frayed shield wires coming in contact with the inside of the head.
- Grounding of shield wires, if required, should be at one place at the end inside the main instrument panel. Before grounding, an isolation test using a 50vdc Mega should be conducted between the shield, conductors, and ground to insure no secondary ground loops exist.
- 5. Compensating lead wire should not be run through with the power line channels. Induced voltages with sufficient power to cause instrument problems have been known to exist.
- Ideally, compensating lead wire should be run through solid conduit. If a flexible connection is made to the terminal head it should 6. incorporate an electrical isolator.

GS (Grain Stabilized) Platinum

Traditional glass immersion sheaths have been produced with 10%, or 20% alloys of rhodium in platinum. Experience has shown that GS platinum can be a direct substitute for these alloys and has been successfully used to replace rhodium and subsequent inherent cost. In addition, sheaths being free of rhodium are not subject to attack by amber glass. The use of GS platinum permits direct immersion control to be obtained in this otherwise difficult processes.

Enclad®:

Enclad® was introduced to the glass industry in the early 1960s. It is now specified routinely by a number of quality glass producers and engineering houses for use in bottom immersion applications. Enclad® is a precisely controlled combination of thermocouple wires, crushable ceramic and metallic sheath that is assembled under clean conditions and consolidated to an integral product. During the assembling process, the metal sheath is joined to the ceramic, pulverizing it to compact around the wires and densifies the composite to be void free. Enclad® thermocouples are not subject to failure due to airborne dust, dirt, or vapors as conventional thermocouples are. When Enclad® is assembled with precious metal sheaths into otherwise conventionally designed thermocouples, campaign life has been obtained with excellent retention of calibration. It has been successful in obtaining campaign life and solving problems in electric melt/boost applications. This concept is now copied by a number of independent thermocouple assembly shops.

This catalogue presents only a limited number of select designs from the many variations gathered over the years. These models represent the latest practical usage and span the range from the lowest cost, simplest design for "in block" applications, to direct immersion configurations whose performance is measured in terms of years of service.

How to specify glass melter bottom thermocouples

Each thermocouple has a unique part number. This part number, four digits preceded by "01" — defines the basic design. To this number must be added a code for the wire calibration and the required dimensions to enable the device to fill the specified application. Please review the Installation Recommendation section before deciding on required dimensions.

Order number



S = Pt - Pt10Rh R = Pt - Pt13Rh

B = Pt6Rh - Pt30Rh

For select bottom thermocouple designs, a quantity of material as well as finished assemblies are kept in stock to provide rapid response to field replacement needs and short turn-around time during rebuilds. The designs and sizes shown to the right are generally available, but this is naturally subject to previous demand.

Model number	Calibration	L1 (in inches)	L2 (in inches)
01-2080 and 01-2205 R, S, в	DSp	18, 24, 30	6
	К, О, В	14, 20, 26	10
01-2090 and 01-2095		18, 30	6
	К, З, В	14, 20, 26	10
01-2060	R, S, в	8, 12, 14	10

Information on each design is provided below.

Note: 1 inch = 25.4 mm.

Note: When duplex thermocouples are ordered, it is possible to locate the junctions on the same or different location from the tip. In the latter case, please consult with customer service.

Small Diameter Thermocouples for "in block" Furnace Bottom



Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

Small sheath diameter allows for easy installation of the thermocouple when retrofitting is required. A $\frac{1}{2}$ diameter hole drilled up to the paving is all that is required.

Number	Description
01-2100-Cal-L1-L2	Simplex
01-2105-Cal-L ₁ -L ₂	Duplex

For select bottom thermocouple designs, a quantity of material as well as finished assemblies are kept in stock to provide rapid response to field replacement needs and short turn-around time during rebuilds. The designs and sizes shown to the right are generally available, but this is naturally subject to previous demand.

Please consult the following pages for details of each design.

Model number	Calibration	L1 (in inches)	L2 (in inches)
04 0000 and 04 0005	01-2080 and 01-2205 R, S, в	18, 24, 30	6
01-2000 and 01-2205		14, 20, 26	10
01-2090 and 01-2095	R, S, в	18, 30	6
		14, 20, 26	10
01-2060	R, S, в	8, 12, 14	10

Information on each design is provided below.

Note: 1 inch = 25.4 mm.

Note: When duplex thermocouples are ordered, it is possible to locate the junctions on the same or different location from the tip. In the latter case, please consult with customer service.

Small Diameter Thermocouples for "in block" Furnace Bottom



Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

Small sheath diameter allows for easy installation of the thermocouple when retrofitting is required. A $\frac{1}{2}$ diameter hole drilled up to the paving is all that is required.

Number	Description
01-2100-Cal-L1-L2	Simplex
01-2105-Cal-L1-L2	Duplex



Dual Sheath, Bottom "in block" Thermocouple

Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

Dual sheath designs provide optimum protection to the thermocouple wires. In the event of glass or metal drilling the sheaths offer greater resistance than a single unit of comparable dimensions.

This design has evolved over the years as the standard in bottom paving applications. Fibro[®] Platinum wire is supplied on type S & R calibrations for optimum stability and service.

Number	Description
01-2090-Cal-L ₁ -L ₂	Simplex, with 0.020" dia. wire
01-2095-Cal-L ₁ -L ₂	Duplex, with 0.020" dia. wire
01-2210-Cal-L ₁ -L ₂	Simplex, with 0.032" dia. wire
01-2215-Cal-L1-L2	Duplex, with 0.032" dia. wire

Dual Sheath with a Grain Stabilized Platinum Insert



Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

The purpose of this design is to meet the challenges when producing lead glass or glasses where high metal content cullet is melted. The outer ceramic sheath is self-sacrificing and, by raising the alumina content of the reactants, tends to dampen the reactions sufficiently so that the ODS thimble can withstand such conditions. Each case must be evaluated separately since, no two lead drilling or tramp metal problems are the same.

Number	Description
01-2220-Cal-L ₁ -L ₂	Simplex, with 0.020" dia. wire
01-2310-Cal-L ₁ -L ₂	Duplex, with 0.020" dia. wire
01-2315-Cal-L ₁ -L ₂	Simplex, with 0.032" dia. wire
01-2320-Cal-L ₁ -L ₂	Duplex, with 0.032" dia. wire

Fibro[®] Platinum wire is supplied on type S & R calibrations for optimum stability and service.

Full Length Sheath Immersion Thermocouple, Standard Strength



Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

This is a utility immersion thermocouple with many successful applications to its long history. It brings together the greatest compromise in life and economy for sustained service use.

Fibro[®] Platinum wire is supplied on type S & R calibrations for optimum stability and service.

Number	Description	
01-2060-Cal-L ₁ -L ₂	Simplex, with 0.020" dia. wire	
01-2225-Cal-L ₁ -L ₂	Duplex, with 0.020" dia. wire	
01-2230-Cal-L ₁ -L ₂	Simplex, with grain stabilized ODS Pt sheath	
01-2235-Cal-L ₁ -L ₂	Duplex, with grain stabilized ODS Pt sheath	

Options



Full Length Sheath Immersion Thermocouple, High Strength

Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

This immersion thermocouple design evolved for applications requiring greater than normal resistance to bending or flexing. It is recommended for deep immersions up to 6 inches and where throat flow might be a problem. Also usable in all applications where experience has shown shorter than normal life is due to glass penetration caused by sheath flexure stress induced cracking.

Fibro[®] Platinum wire is supplied on type S & R calibrations for optimum stability and service.

Number	Description
01-2050-Cal-L ₁ -L ₂	Simplex, with 0.032" dia. wire
01-2240-Cal-L ₁ -L ₂	Duplex, with 0.032" dia. wire
01-2245-Cal-L ₁ -L ₂	Simplex, with 0.032" dia. wire and grain stabilized platinum sheath
01-2250-Cal-L ₁ -L ₂	Duplex, with 0.032" dia. wire and grain stabilized platinum sheath

Full Length Sheath Immersion Enclad® Thermocouple, Std. Strength



Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

This light weight Enclad[®] Immersion thermocouple design has been standardized for use by most major glass engineering contractors and consultants. It finds excellent use in electric melters as well as gas/oil combustion plants. It is extensively used for side wall applications with immersion depths held to 2 inches.

Fibro[®] Platinum wire is supplied on type S & R calibrations for optimum stability and service.

Number	Description
01-2010-Cal-L ₁ -L ₂	Simplex
01-2240-Cal-L ₁ -L ₂	Duplex
01-2245-Cal-L ₁ -L ₂	Simplex, with grain stabilized platinum sheath
01-2250-Cal-L ₁ -L ₂	Duplex, with grain stabilized platinum sheath

Full Length Sheath Immersion Enclad® Thermocouple, High Strength



Ordering Information

When ordering, please specify the full number of the thermocouple: Model Number - calibration code - dimensions L1-L2.

Options

30 years' experience with this design has proven its effectiveness in delivering campaign life with stable, reliable performance. Extensively used in float and fiber glass plants where flow rates and operating temperatures are at the extreme. Also, used successfully in throat applications with immersions up to 6 inches.

Fibro[®] Platinum wire is supplied in types S & R calibrations for optimum stability and service.

Number	Description
01-2020-Cal-L ₁ -L ₂	Simplex
01-2030-Cal-L1-L2	Duplex
01-2270-Cal-L1-L2	Simplex, with grain stabilized platinum sheath
01-2275-Cal-L1L2	Duplex, with grain stabilized platinum sheath



Shortened Thimble Composite Immersion/Paving Thermocouple

Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions $L_1-L_2 - L_3$.

Options

This design has a proven record with over 30 years of use. The thimble can be immersed in the glass or, used as added protection against drilling or block cracking in dead end applications. By limiting the thimble length to the glass penetration depth, a compromise can be made between economy and assembly rigidity. With the Enclad[®] internal element, full protection is afforded the thermocouple wires regardless of glass intrusion.

All thimbles are supplied non-cemented, and, they can be supplied cemented by special order.

Fibro[®] Platinum wire is supplied in types S & R calibrations for optimum stability and service.

Number	Characteristic
01-2040-Cal-L ₁ -L ₂ -L ₃	Enclad®
01-2280-Cal-L1-L2-L3	Enclad [®] , with a flange
01-2285-Cal-L1-L2-L3	Enclad $^{\ensuremath{\mathbb{S}}}$, with grain stabilized platinum thimble
01-2290-Cal-L ₁ -L ₂ -L ₃	Enclad $^{\ensuremath{\mathbb{R}}}$, with grain stabilized platinum thimble and flange
01-2070-Cal-L ₁ -L ₂ -L ₃	Slip fit, with 0.032" dia. wire
01-2295-Cal-L1-L2-L3	Slip fit, with 0.032" dia. wire and flange
01-2300-Cal-L ₁ -L ₂ -L ₃	Slip fit, with 0.032" dia. wire and grain stabilized platinum thimble
01-2305-Cal-L ₁ -L ₂ -L ₃	Slip fit, with 0.032" dia. wire and grain stabilized platinum thimble and flange

Installation recommendations - Bottom

The following installation recommendations are based on the best experience available to date. However, each tank must be considered independently and selectively to determine if these recommendations are appropriate. Except in electrified tanks where complete isolation is mandatory great freedom of choice exists as to how to mount each thermocouple. BASF is always pleased to consult with you on your installation and thermocouple design details. Please feel free to call the nearest Sales/Service center for assistance.



Refractory layer contact (non-glass)

Suitable for all non-immersion designs as well as Model No. 01-2040. If the holes are drilled hot they should be as small as possible. (Typically 9/16 to 1" diameter). If the entrance hole is drilled prior to heat up to allow 2" to 4" diameter for all lower courses.



Cold end mounting

It is generally preferred to let a flange carry the entire weight of the thermocouple without rigid attachment for full length metal sheath thermocouples. By providing a large pass through hole in the base plate the thermocouple is free to shift slightly with tank expansions and /or contractions. Angle brackets can be welded across the tank "I" beams (preferred) or to the bottom casing.

For rigid clamping, it is recommended to isolate all clamps, hangers, or struts. This mounting approach has merit for those thermocouple designs that extend beyond the construction "I" beams and are subject to traffic and possible physical impact.





Immersion thermocouple

A common approach to immerse a thermocouple through a multilayer bottom. Shown is the short thimble thermocouple, Design No. 01-2040 with a flanged modification. Cooling air may be required to insure glass seal off.

Dead End Block

A recommended approach for high lead and/or glasses with high metal cullet levels. This installation is recommended with catalogue number: 01-2090 or 01-2040 designs. The hole diameter within the block should be as small as possible for the top 6 to 10 inches and counter bored to 2 inches if experience dictates the block will crack and possibly shear.



Direct immersion

Full length thimble designs can extend up to 4 inches beyond the bottom of the block, however little is gained beyond 2 inches. The hole diameter should be kept to a minimum (9/16" to 1") and counter bored only if shifting, tilting, or shear cracking are anticipated. By installing blocks with one or two additional blind holes in them, hot drilling and insertion of replacement thermocouples, bubbler tubes, etc., can be easily accommodated.



Components

Polyester mounting plate



Standard mounting flange



Use with the standard mounting flange is recommended (see below). This sheet provides efficient electrical insulation between the thermocouple and the tank ground. It also allows a low friction surface for the flange which, allows it to shift within the mounting space as the furnace expands.

Ordering Information

Specify

Part No.: 00-8080 8" x 8" inch square (shown to the left)

Part No.: 00-8090 for 10" x 10" inch square

A stainless steel flange with three adjustable screws conveniently supports a crown thermocouple.

Ordering Information

Specify

Part No.: 00-8010-01





Information for Field Installation

Specify

00-6100 - calibration code - length (L) in feet

(6 feet is recommended, 1 foot = 304.8mm).

Note:

For flexible stainless steel protective cover.

Specify

00-6105 - calibration code - length (L) in feet.

Adding compensating extension cables with preassembled electric wiring facilitates crown thermocouple installation. It is easier to replace and check devices, if a plug connector is located at some distance from the furnace crown. The lead wire is impregnated high-temperature glass, with a glass braid jacket. A mating connector, and strain relief clamp is provided for convenient connection into the thermocouple head.

Note:

The compensating extension wire can be ordered as part of the full thermocouple assembly.

Specify the thermocouple code and the number of the extension wire.

Example

"Thermocouple 01-6010-S-24-6 with the connected wire 00-6100-S-6" means a dual sheath crown thermocouple with the 6 feet long extension wire terminated with a plug and jack.

Thermocouples for the Forehearth

Introduction

It is general knowledge that pack efficiency is strongly related to the gob temperature uniformity. Several reports show an increase from the 85-88% range to 94-96% level for associated reductions in feeder gradients to 1°C or less. To accomplish this level of uniformity, the industry has various forehearth control strategies. Several technologies include top, bottom and even sidewall glass cooling strategies. Traditional heating, along with distributed and model based "path forward" control strategies are also utilized.

Regardless of the approach taken, two key items have proven indispensable to the successful control of the forehearth temperature gradient: 1) reliable sensors that provide the necessary intelligence from within the glass, 2) competent process control strategies to properly utilize the information provided.

With over 80 years' experience in the glass industry, BASF can provide unique designs to meet the challenging needs in these applications. From heavy duty high performance models that are designed to last a full forehearth campaign; to, our reduced precious metal models that offer a balance between precious metal consumption and optimum life, BASF has the design to meet your needs.

Specifications

BASF's Forehearth thermocouples are manufactured with insulation made of high purity alumina (Al₂O₃). The alumina content is at least 99.7%. It is well known that high purity alumina is necessary for steady operation of thermocouples made of precious metals used at high temperatures. However, please note that the type and nature of the remaining impurity elements is also important. To exclude well known detrimental impurities like Fe, Ni, Cr, Sb, high purity alumina is recommended. Also, it is important to consider concentration of certain glass components like B₂O₃, SiO₂, Na₂O, etc. and their combinations when making the selection.

Wires used in all the thermocouples are selected and calibrated according to ISA, ANSI or IEC reference tables within ±0.25% of temperature between 400°C and 1450°C. All thermocouples delivered within the same order are manufactured using the wires from the same lot. This guarantees that all thermocouples provide equivalent data. Data on the lot calibration and on calibration of a certain device are available at extra change.

GS (Grain Stabilized) Platinum

Traditional glass immersion sheaths have been produced with 10%, or 20% alloys of rhodium in platinum. Experience has shown that GS platinum can be a direct substitute for these alloys and has been successfully used to replace rhodium and subsequent inherent cost. In addition, sheaths being free of rhodium are not subject to attack by amber glass. The use of GS platinum permits direct immersion control to be obtained in this otherwise difficult processes.

Enclad[®]:

Enclad[®] was introduced to the glass industry in the early 1960s. It is now specified routinely by a number of quality glass producers and engineering houses for use in bottom immersion applications. Enclad[®] is a precisely controlled combination of thermocouple wires, crushable ceramic and metallic sheath that is assembled under clean conditions and consolidated to an integral product. During the assembling process, the metal sheath is joined to the ceramic, pulverizing it to compact around the wires and densifies the composite to be void free. Enclad[®] thermocouples are not subject to failure due to airborne dust, dirt, or vapors as conventional thermocouples are. When Enclad[®] is assembled with precious metal sheaths into otherwise conventionally designed thermocouples, campaign life has been obtained with excellent retention of calibration. It has been successful in obtaining campaign life and solving problems in electric melt/boost applications. This concept is now copied by a number of independent thermocouple assembly shops.

This catalogue presents only a limited number of select designs from the many variations gathered over the years. These models represent the latest practical usage and span the range from the lowest cost, simplest design for "in block" applications, to direct immersion configurations whose performance is measured in terms of years of service.

Each thermocouple has a unique part number. This number with "01" suffix defines the basic design. Add the wire calibration code and the dimensions required for each case.

Order number



Calibration code

S = Pt - Pt10Rh

R = Pt - Pt13Rh

B = Pt6Rh - Pt30Rh

We have sufficient quantity of thermocouples for any size, number and design in stock to provide for quick replacement or return in case of repair.

Note: 1 inch = 25.4 mm.



Traditional Full Length Tri- Level Thermocouple

Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions L1-to - L5.

This design provides the best balance between performance and precious metal content with greater than 5 years' service life reported. This design also provides good mechanical strength which allows for optimum ease of installation.

Number	Description
01-3065-Cal-L1 -L2-L3-L4-L5	0.435" diameter thimble with 0.011" wall thickness

Traditional Reduced PM Tri- Level Thermocouple



Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions L_1 -to - L_6 .

When precious metal reduction is a priority, this design provides proven reliability and typical service life is over 2.5 years with, service life of over 4 years reported. Since this assembly has ceramic components, care must be taken when handling and installing.

Number	Description
01-3015-Cal-L1-L2-L3-L4-L5-L6	0.435" diameter thimble with 0.011" wall thickness





Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions L_1 -to - L_6 .

The ultimate design when precious metal reduction is a priority, this design provides the lowest precious metal content while balancing performance. Proven reliability and typical service life is 1.5 to 3.0 years with, service life of over 4 years reported. Heavy wall alumina support tube provides extra strength for installing etc..

Number	Description
01-3365-Cal-L ₁ -L ₂ -L ₃ -L ₄ -L ₅₋ L ₆	0.540" diameter thimble with 0.007" wall thickness

Heavy-Duty, High Strength Tri- Level Thermocouple



Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions L1-to - L5

One of the best designs when service life is a priority, this design provides the best balance between precious metal content, strength and service life. Proven reliability and typical service life is 3 to 5 years with, service life of over 6 years reported. Heavy wall thimble provides extra strength for installing etc..

	Number	Description
i	01-3040-Cal-L1-L2-L3-L4-L5	0.750" diameter thimble with 0.015" wall thickness



High Strength, Long Life PM Tri- Level Thermocouple

Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions L1-to - L5

The ultimate design when service life is a priority, this design provides the maximum service life and strength. Proven reliability and typical service life is 4 to 6 years with, service life of over 7 years reported. Heavy wall thimble provides extra strength for installing etc.. BASF's Enclad[®] thermocouples are utilized for maximum strength and service life.

Number	Description
01-3100-Cal-L ₁ -L ₂ -L ₃ -L ₄ -L ₅	0.445" diameter thimble with 0.015" wall thickness

Reduced PM Tri-Level Thermocouple with Glass Line Protection Sleeve



Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions L_1 -to - X

	Number	De
This design offers a specially designed protection sleeve which provides extra protection against hostile conditions at the glass-	01-3475-Cal-La-La-La-La-La-La-La-La-La-La-La-La-La-	04
atmosphere interface. Thus, providing longer service life while using	L6-X	0.0
the minimum amount of PM. Proven reliability and typical service life is		pro
2.5 to 4 years with, service life of over 5 years reported		thic

iber	Description
475-Cal-L ₁ -L ₂ -L ₃ -L ₄ -L ₅ -	0.408" diameter thimble with 0.007" wall thickness and with protective sleeve 0.020" thickness



Traditional Reduced PM Simplex Thermocouple

Ordering Information

When ordering, please specify the full number of the thermocouple: Design code - calibration - dimensions L1-to - L4

When precious metal reduction is a priority, this design provides proven reliability and typical service life is over 2.5 years with, service life of over 4 years reported. Since this assembly has ceramic components, care must be taken when handling and installing.

	Number	Description
s e	01-3175-Cal-L ₁ L ₂ -L ₃ -L ₄	0.435" diameter thimble
С		With 0.011" wall thickness

Components

Tripod



The basic diameter is 6.5"

Nominal size is 1.097" This 300 series stainless steel tripod securely supports all thermocouples. The thermocouple is fixed at any height by tightening two 5/16 inch bolts on the mounting tube.

Ordering Information

Part No. : 00-8030

Standard mounting flange



A stainless steel flange with three adjustable screws conveniently supports a crown thermocouple.

Ordering Information Specify Part No. : 00-8010-01

Forehearth TC Installation Guide

Alumina is a material very sensitive to mechanical and thermal shocks. Great care and attention must be paid when taking the thermocouples out of the shipping boxes, avoiding any mechanical impact with hard or sharp materials. Alumina is also very notch sensitive. Avoid any impact that may cause a notch in the alumina.

The thermocouples should be handled with clean gloves at all times, to avoid any possible contamination coming from the hands of the operators and the manufacturing environment.

Any contact of the thermocouple with lubricants, oils of any type, soft or hard metals should be avoided at all times.

All thermocouples, when in storage, must be kept in a clean and dry environment, protected from the dust. The best would be to keep them in the shipping box, in their protection plastic protection bags, until just before the installation.

Installation:

- 1. Pre-heat TC by laying it on top of forehearth for a few hours. CAUTION: keep the thimble clean and clear of debris.
- 2. Install into forehearth slowly. It should take 45 to 60 seconds from start to finish (no need for "mm" to "mm" slowness).
- 3. Weight of T/C must not rest on tip of TC.
- 4. Touch the bottom of the forehearth and pull up 5 to 6 mm. The entire TC will thermally expand this amount. It takes 2 to 3 hours for the entire TC (head-pipe, etc.) to come to full expansion temperature. CAUTION: Do not apply force of any means to avoid damage to the Platinum sheath &/ Thermocouple
- 5. Use ridged clamps to hold TC by the pipe. Tripod base or angle iron bracket must be tightly clamped.
- 6. After 2 to 3 hours, it is a good idea to loosen the clamp and reposition the TC. It is recommended to touch the bottom of the forehearth to test if the expansion is more than the clearance and if the tip of the TC is bearing any weight.
- 7. Pack or cover the entrance hole/slot so flames and hot gasses do not impinge on the head or connection cables. Avoid chimney effect. Do not insert a thermocouple into a pipe leading directly from the entrance to the Head of the thermocouple.
- 8. Route the lead cables away from grease, oil, heat, flames, etc. and connect to instruments.
- The Thermocouple, in its installation holder, should be totally electrically insulated versus the hardware of the forehearth (ground), to avoid the electrolytic corrosion which may take place on the Platinum sheath and to avoid any electrical interference with the signal (EM) of the Thermocouple.
- 10. It is suggested, that if a metal tag is connected to the head, that it be removed and reconnected to one of the connector plugs. This protects the tag from heat damage and permits easy tracking of serial number, installation date, etc.
- 11. If TC must be removed, it must be pulled straight up without angling and/or twisting at the head or lead wires. Remove slowly. Resecure or hold the TC up at intervals, until the glass on the sheath runs off. This is especially important if the entrance hole is small (less than 25 to 50 mm) and this step will also assist in avoiding thermal shock to the TC.
- 12. The TC must be held vertically until it cools to a uniform temperature. Do not lay red-hot TC's on top of the forehearth or on any flat surface.

About BASF's Temperature Sensing Products

For decades, BASF has supplied a wide range of industries, including semiconductor, glass, solar cell, chemical, crystal growth, heat treating, laser welding, gas turbine, bio-medical, and others with exceptionally high quality temperature-sensing products and temperature sensor calibration services to meet the demanding applications of our customers.

Metals - particularly those in the platinum group - are critical components of many products made by BASF such as contact thermocouples. The experience of our research and development group in precious metal and precious metal technologies is unmatched. From Fibro[®] platinum to Platinel[®] thermocouple wire, we have led the industry with breakthrough innovations. No one knows more about precious metals.

For more information, visit www.catalysts.basf.com/tempsensing or contact BASF:

United States and Canada 46820 Fremont Blvd. Fremont, CA 94538 USA Tel: 510-490-2150 Europe Via Di Salone 245 00131 Rome Italy Tel: 39-0641-992-306

About Us

BASF's Catalysts division is the world's leading supplier of environmental and process catalysts. The group offers exceptional expertise in the development of technologies that protect the air we breathe, produce the fuels that power our world and ensure efficient production of a wide variety of chemicals, plastics and other products, including advanced battery materials. By leveraging our industry leading R&D platforms, passion for innovation and deep knowledge of precious and base metals, BASF's Catalysts division develops unique, proprietary solutions that drive customer success.

BASF – We create chemistry

Asia

7 Temasek Blvd. #35-01 Suntec Tower One Singapore 038987 Tel: 65-6337-0330

Although all statements and information in this publication are believed to be accurate and reliable, they are presented gratis and for guidance only, and risks and liability for results obtained by use of the products or application of the suggestions described are assumed by the user. NO WARRANTIES OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE MADE REGARDING PRODUCTS DESCRIBED OR DESIGNS, DATA OR INFORMATION SET FORTH. Statements or suggestions concerning possible use of the products are made without representation or warranty that any such use is free of patent infringement and are not recommendations to infringe any patent. The user should not assume that toxicity data and safety measures are indicated or that other measures may not be required. © 2017 BASF Corporation

© 2017 BASF, Florham Park, NJ. All rights reserved. BF-6476 09/17