

SURFACE THERMOCOUPLES

I Why we want to put surface thermocouples on the vessel wall ?

We want to get boundary conditions for the experiments, and to be able to see if there is some heat exchanges on the vessel wall. It also enables us to establish a more accurate radial temperature profile.

II What are those thermocouples

II.1 Thermocouples

Thermocouple used are Surface Thermocouple with Self-Adhesive Backing from Omega. There are T-thermocouples : Copper Constanstan. The general specification are on the Omega Website ([link](#)), or at the end of this document. Those thermocouples can work in the following temperature range : from -60°Celsius to 175°Celcius (from -75°F to 350°F).

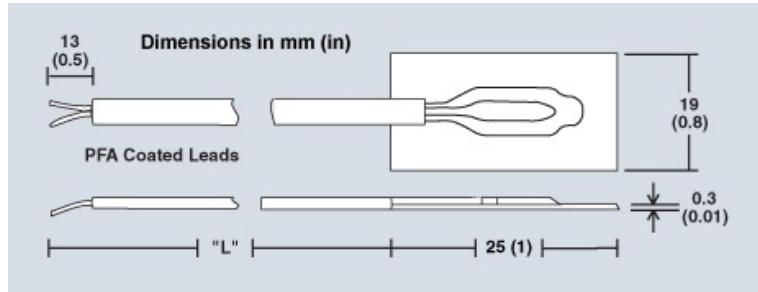


FIGURE 1 – Thermocouple scheme

II.2 Connectors

Connectors used are Miniature Thermocouple Connectors from Omega. They are male and female connectors, suited for T-wires. The general specifications are on the Omega website([link](#)), or included at the end of this document.

II.3 Wires

Wires used are TG-T-30 from Omega. Other wire is used (orange wrapped one). Omega website([link](#)), or included at the end of this document.

III How they are set ?

III.1 Where we want to put them ?

In order to choose the location on the vessel, we can look at Mario Magliocco results :

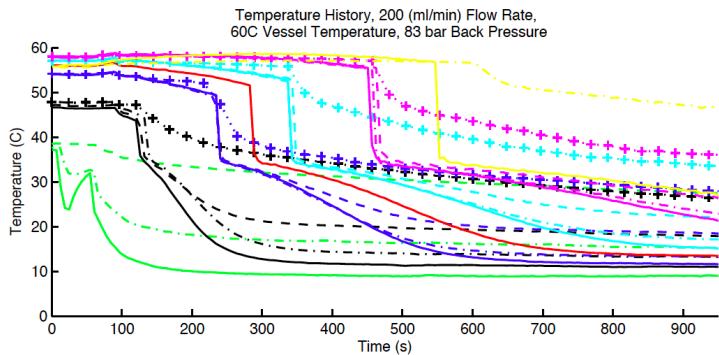


FIGURE 2 – Temperature in the vessel vs time data

If we look for the initial conditions, the temperature gradient versus vertical location appears more important at the bottom of the vessel. As a consequence, we will try to put surface thermocouples all along the vessel - and on both the top and bottom cap - but more focused at the bottom of the vessel. Naturally, we also want to collect data at the same vertical levels than the thermocouples inside the vessel.

III.2 General settings

The surface thermocouples are set on a cleaned part of the vessel : Then the wires come



FIGURE 3 – Temperature in the vessel vs time data

through a PVC pipe, and are connected to other wires thanks to male/female connectors. The datas are then received by the computer.

III.3 precise location and channels used :

These informations are essential in order to import the datas :

Thermocouples	Target location	Real location	M Conn.	F Conn.	Channel	Input
A	0	0	A	A	5	25
B	5	5.3	B	B	7	27
C	10	9.7	C	C	8	28
D	15	14.7	D	D	9	29
E	20	19.8	E	E	10	30
F	25	24.6	F	•	•	•
G	30	29.6	G	G	11	31
H	40	39.5	H	H	12	32
I	50.8	50.5	I	I	13	33
J	top cap	58.7	J	J	6	26

Location are give in centimeters. Connector letters and channels are not suited because I cut some wires during the settings.

III.4 Remarks :

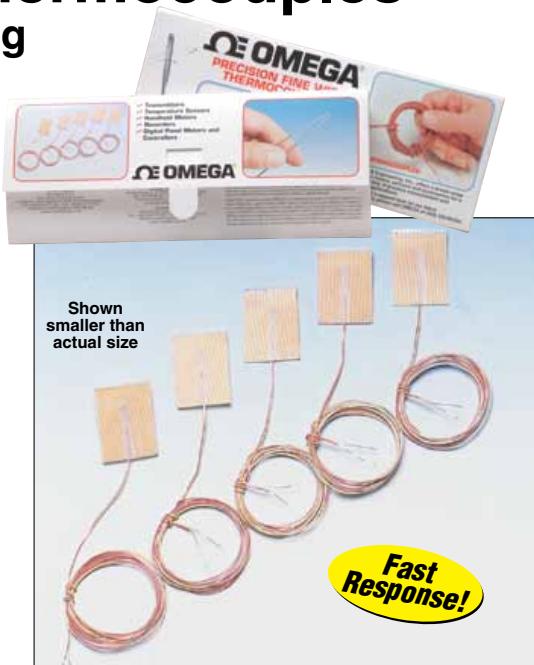
- Wires from thermocouples to female connectors are really weak. In order to prevent them fro being cut, they are put in a PVC tube from the vessel to the wall.
- As some cable were missing, the thermocouples F is not linked to the computer. This thermocouple seem to be the less usefull one, as we want to focus on both the inside thermocouples vertical positions and the bottom of the vessel. However, this thermocouples have been tested with a female connector and a channel, it works.
- The simulation models, run with python, should use the initial datas from those thermocouples in order to use boundary conditions.

Fast Response Thermocouples With Self-Adhesive Backing

- ✓ Self Adhesive Backing for Easy Installation
- ✓ Better Than 0.3 Second Response Time
- ✓ 1 m (40") or 2 m (80") Color-Coded PFA Insulated Leads
- ✓ Rated to 175°C (350°F) Long Term
- ✓ Available in J, K, T, and E Calibrations

SA1 Series

MEETS OR EXCEEDS
SPECIAL UNITS (SLE)
JIS C 4505-2:
Tolerance Class 1



To Order Visit omega.com/sa1 for Pricing and Details

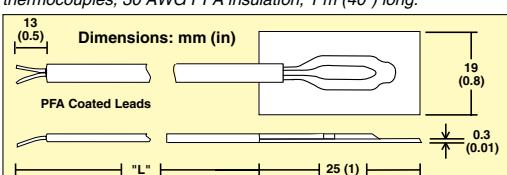
Model No.	Description, "L" Dimension, Termination
SA1-(*)	Thermocouple, 1 m (40") long, stripped ends
SA1-(*)-72	Thermocouple, 2 m (80") long, stripped ends
SA1-(*)-120	Thermocouple, 3 m (120") long, stripped ends
SA1-(*)-SRC	SA1-(*) with molded strain relief and SMP male connector

* Specify J, K, T or E thermocouple type.

For a male straight M8 plug add "M8-S-M" to the model number for additional cost. For a male straight M12 plug add "M12-S-M" to the model number for additional cost.

For a male right-angled M8 plug add "M8-R-M" to the model number for additional cost. For a male right-angled M12 plug add "M12-S-M" to the model number for additional cost.

Ordering Example: SA1-K, pkg of 5 self-adhesive Type K thermocouples, 30 AWG PFA insulation, 1 m (40") long.



With Miniature Connector and Spool Caddy



Shown smaller than actual size.

Now Available!
M8/M12
CONNECTORS



**Convenient
Packages
of 5**

175°C (350°F) Temperature Rating

**Conveniently
Store Thermocouple
Wire On the
Spool Caddy**

To Order Visit omega.com/sa1 for Pricing and Details

Model No.	Wire Gauge	Length m (in)	Insulation
SA1-J-SC	30	1 (40)	PFA
SA1-K-SC	30	1 (40)	PFA
SA1-T-SC	30	1 (40)	PFA
SA1-E-SC	30	1 (40)	PFA
SA1-J-72-SC	30	2 (80)	PFA
SA1-K-72-SC	30	2 (80)	PFA
SA1-T-72-SC	30	2 (80)	PFA
SA1-E-72-SC	30	2 (80)	PFA

Note: 2 m (80") is the longest length available with spool caddy.

Ordering Example: SA1-K-SC, package of 5 self-adhesive Type K thermocouples, 30 AWG PFA insulation, 1 m (40") long.

Most Popular Miniature Connectors

Type SMPW Glass Filled Nylon

-29 to 220°C (-20 to 425°F) Service Temperature

Type HMPW Liquid Crystal Polymer

260°C (500°F) Service Temperature

 MONOGRAM[®]
SERIES

HMPW/SMPW
Basic Pair

- ✓ Heavy Duty Construction
- ✓ Color-Coded for ANSI and IEC
- ✓ Captive Cover Screws
- ✓ Accepts Stranded or Solid Wire up to Size 20 AWG
- ✓ Quick Connect Contact Washers
- ✓ Internal Wire Divider
- ✓ Combination Phillips/Slot Screws
- ✓ Type HMPW Environmentally Friendly Cadmium-Free



SMPW
-29 to 220°C



HMPW
-29 to 260°C

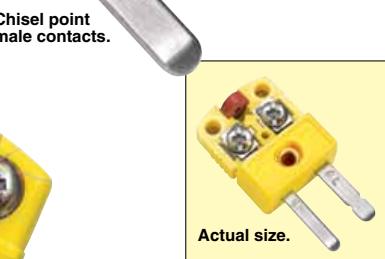


SMPW — Glass-Filled Nylon
HMPW — Cadmium Free Liquid Crystal Polymer
Shown smaller than actual size.

We make running changes when technical advances allow. Check at time of ordering for additional features.



Removable/reversible write-on window at no extra charge.

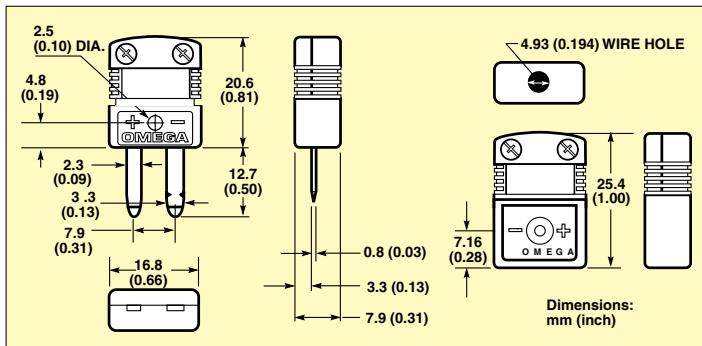


Crimp Style Brass and Stainless Steel Bushing



Available in sizes to fit 0.020 to 0.125" and 1.5 and 3.0 mm diameter probes, visit omega.com

Visit omega.com
to See OMEGA's Complete
Selection of Connector
Accessories



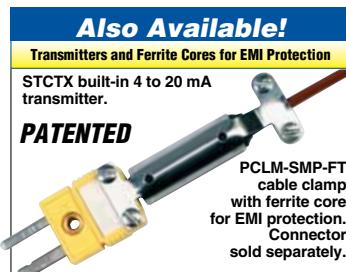
The write-on connector is a trademark of OMEGA Engineering, Inc. Additional write-on windows available, order WCP-S, pkg of 5.



Quick connect contact washers. Additional washers available, order CW-SMP-20, pkg of 20, or CW-SMP-100, pkg of 100



Liquid crystal polymer miniature connector shown actual size.



Discount Schedule	
1-10	Net
11-49	5%
50-99	10%
100-999	15%
1000-4999	20%
5000 and over	25%

To Order Visit omega.com/smpw_smp_hmp_hmpw for Pricing and Details

Alloy Code†	Compensating Alloy Used in Connector		Shell Color	Glass-Filled Nylon Model Number w/Window	Liquid Crystal Polymer Model Number w/Window
	+	-			
K	Chromega®	Alomega®	Yellow	SMPW-K-(*)	HMPW-K-(*)
T	Copper	Constantan	Blue	SMPW-T-(*)	HMPW-T-(*)
J	Iron	Constantan	Black	SMPW-J-(*)	HMPW-J-(*)
E	Chromega®	Constantan	Purple	SMPW-E-(*)	HMPW-E-(*)
R/S	Copper	RNX/SNX	Green	SMPW-R/S-(*)	HMPW-R/S-(*)
G	GPX	GNX	Red/Grn	SMPW-G-(*)	HMPW-G-(*)
C	CPX	CNX	Red	SMPW-C-(*)	HMPW-C-(*)
D	DPX	DNX	Red/Wht	SMPW-D-(*)	HMPW-D-(*)
U	Copper	Copper	White	SMPW-U-(*)	HMPW-U-(*)
N	Omega-P®	Omega-N®	Orange	SMPW-N-(*)	HMPW-N-(*)

*To Order: Specify "MF" for a connector pair, "M" for male connector only, or "F" for female connector only.

†J, K, T, E, R, S and B are ANSI designations. OMEGALLOY® is generically known as Nicrosil-Nisil. ANSI color coded models shown.

Note: Non-Window models available, please consult Sales for details.

Type U (uncompensated) connectors are used with Type B thermocouples (Pt/6%Rh-Pt/30%Rh).

Ordering Examples: SMPW-K-MF, glass-filled nylon, Type K connector pair. SMPW-K-M, glass-filled nylon, Type K male connector.

SMPW-K-F, glass-filled nylon, Type K female connector. HMPW-K-MF, liquid crystal polymer, Type K connector pair.



**“SLE” Special
Limits of Error
Available**



ANSI color code shown
To order IEC color code visit omega.com

ANSI Color Code: Positive Wire, Blue; Negative Wire, Red; Overall, Brown
 OMEGA Engineering does not use reprocessed PFA or PVC in manufacturing thermocouple wire.

To order visit omega.com/gg_t_tc_wire for Pricing and Details

Insulation	AWG No.	Model Number	Type Wire	Insulation		Max Temp		Nominal Size mm (inches)	Wt. [†] kg/300 m (lb/1000')
				Conductor	Overall	°C	°F		
Glass	20	GG-T-20	Solid	Glass Braid	Glass Braid	260	500	1.5 x 2.4 (0.060 x 0.095)	4 (9)
	20	GG-T-20S	7 x 28	Glass Braid		260	500	1.5 x 2.5 (0.060 x 0.100)	4 (9)
	24	GG-T-24	Solid	Glass Braid		200	400	1.3 x 2.0 (0.050 x 0.080)	3 (5)
	24	GG-T-24S	7 x 32	Glass Braid		200	400	1.3 x 2.2 (0.050 x 0.085)	3 (5)
	26	GG-T-26	Solid	Glass Braid		200	400	1.1 x 1.9 (0.045 x 0.075)	2 (4)
	28	GG-T-28	Solid	Glass Wrap		200	400	1.0 x 1.4 (0.040 x 0.055)	2 (3)
Glass with Stainless Steel Overbraid	30	GG-T-30	Solid	Glass Wrap		150	300	0.9 x 1.3 (0.037 x 0.050)	2 (3)
	20	GG-T-20-SB	Solid	Glass	SS Braid Over Glass	260	500	2.2 x 3.0 (0.090 x 0.120)	6 (14)
	20S	GG-T-20S-SB	Solid			260	500	2.2 x 3.0 (0.085 x 0.117)	5 (11)
	24	GG-T-24-SB	Solid			200	400	2.2 x 3.0 (0.085 x 0.117)	5 (11)
	24S	GG-T-24S-SB	Solid			200	400	2.2 x 3.0 (0.085 x 0.117)	5 (11)
Kapton Polyimide Tape	20	KK-T-20	Solid	Fused Polyimide Tape	Fused Polyimide Tape	260	500	1.5 x 2.5 (0.060 x 0.100)	5 (11)
	24	KK-T-24	Solid		260	500	1.3 x 1.9 (0.050 x 0.075)	3 (6)	
	30	KK-T-30	Solid		260	500	1.0 x 1.4 (0.040 x 0.055)	3 (5)	
PFA Glass	30	TG-T-30	Solid	PFA	Glass Braid	150	300	0.9 x 1.2 (0.034 x 0.047)	1 (2)
	36	TG-T-36	Solid			150	300	0.7 x 1.0 (0.028 x 0.038)	1 (2)
	40	TG-T-40	Solid			150	300	0.7 x 0.9 (0.026 x 0.035)	1 (2)
Neoflon PFA (High Performance)	20	TT-T-20	Solid	PFA	PFA	260	500	1.7 x 3.0 (0.068 x 0.116)	5 (11)
	20	TT-T-20S	7 x 28			260	500	1.9 x 3.2 (0.073 x 0.126)	5 (11)
	22	TT-T-22S	7 x 30			260	500	1.7 x 3.4 (0.065 x 0.133)	4 (9)
	24	TT-T-24	Solid			200	400	1.4 x 2.4 (0.056 x 0.092)	3 (7)
	24	TT-T-24S	7 x 32			200	400	1.6 x 2.6 (0.063 x 0.102)	3 (7)
	30	TT-T-30††	Solid			150	300	0.6 x 1.0 (0.024 x 0.040)	1 (2)
	36	TT-T-36††	Solid			150	300	0.5 x 0.8 (0.019 x 0.030)	1 (2)
	40	TT-T-40††	Solid			150	300	0.4 x 0.7 (0.017 x 0.026)	1 (2)
PFA Polymer w/Twisted and Shielded Conductors	20	TT-T-20-TWSH	Solid	PFA Polymer	PFA Polymer and Shielding	260	500	3.7 (0.15)	9 (20)
	20S	TT-T-20S-TWSH	7 x 28			260	500	3.8 (0.15)	9 (20)
	24	TT-T-24-TWSH	Solid			260	500	2.7 (0.11)	4 (9)
	24S	TT-T-24S-TWSH	7 x 32			260	500	2.9 (0.12)	4 (9)
Neoflon FEP	20	FF-T-20	Solid	FEP	FEP	200	392	1.7 x 3.0 (0.068 x 0.116)	5 (11)
	24	FF-T-24	Solid			200	392	1.4 x 2.4 (0.056 x 0.092)	3 (7)
FEP Polymer w/Twisted and Shielded Conductors	20	FF-T-20-TWSH	Solid	FEP Polymer	FEP Polymer and Shielding	200	392	3.7 (0.15)	9 (20)
	20S	FF-T-20S-TWSH	7 x 28			200	392	3.8 (0.15)	9 (20)
	24	FF-T-24-TWSH	Solid			200	392	2.7 (0.11)	4 (9)
	24S	FF-T-24S-TWSH	7 x 32			200	392	2.9 (0.12)	4 (9)
TFE Tape Polymer	20	TFE-T-20	Solid	TFE Tape Polymer	Fused TFE Tape Polymer	260	500	1.5 x 2.5 (0.060 x 0.100)	5 (11)
	20S	TFE-T-20S	7 x 28			260	500	1.5 x 2.7 (0.060 x 0.105)	5 (11)
	24	TFE-T-24	Solid			260	500	1.3 x 1.9 (0.050 x 0.075)	3 (6)
	24S	TFE-T-24S	7 x 32			260	500	1.3 x 2.2 (0.050 x 0.085)	3 (6)
Polyvinyl	24	PP-T-24	Solid	Polyvinyl	Polyvinyl	105	221	1.9 x 3 (0.075 x 0.120)	5 (10)
	24	PP-T-24S	7 x 32		Polyvinyl	105	221	1.9 x 3.1 (0.080 x 0.130)	5 (10)
	24	PR-T-24	Solid		(Rip Cord)**	105	221	1.3 x 2.2 (0.050 x 0.086)	3 (5)

See Fused Tape Insulated TFE-T Series.

** Two insulated leads bonded together, but with no overjacket.

† Weight of spool and wire rounded to the next highest lb. (does not include packing material).

†† Overall color clear, ††† To order special limits of error wire, add “SLE” to model number before spool length.

Ordering Example: TT-T-24-SLE-1000, 1000' (300 m) of Type T duplex insulated special limits of error thermocouple wire.

Discount Schedule (1000' spools only)

3 to 4 spools.....	10%
5 to 9 spools.....	15%
10 to 19 spools.....	20%

Note: Published prices are based on market value at time of printing and are subject to change due to Nickel surcharges, Chromium and precious-metal market fluctuations.