

Temperature sensors

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Temperature sensors

Thermocouples



Platinum resistors, Pt100



Pt 100



Pt 100 structure and mechanism



- Platinum resistor inside stainless steel sheath packed with MgO for insulation.
- **Platinum resistance varies with temperature** very uniformly over a large temperature range.
- At 0°C the resistance is 100 Ohms, (Pt 500 or Pt 1000 also available)

Pt 100 where we use them



- Fedegari uses Pt 100 probes for controlling sterilization cycles
- Hold their calibration very well
- Very robust




Pt 100 accuracy

Tolerance class	Temperature range of validity °C		Tolerance values ^(a) °C
	Wire wound resistors	Film resistors	
AA	-50 to +250	0 to +150	$\pm (0.1 + 0.0017 t)$
A	-100 to +450	-30 to +300	$\pm (0.15 + 0.002 t)$
B	-196 to +600	-50 to +500	$\pm (0.3 + 0.005 t)$
C	-196 to +600	-50 to +600	$\pm (0.6 + 0.01 t)$

(a) | t | = modulus of temperature in °C without regard to sign.

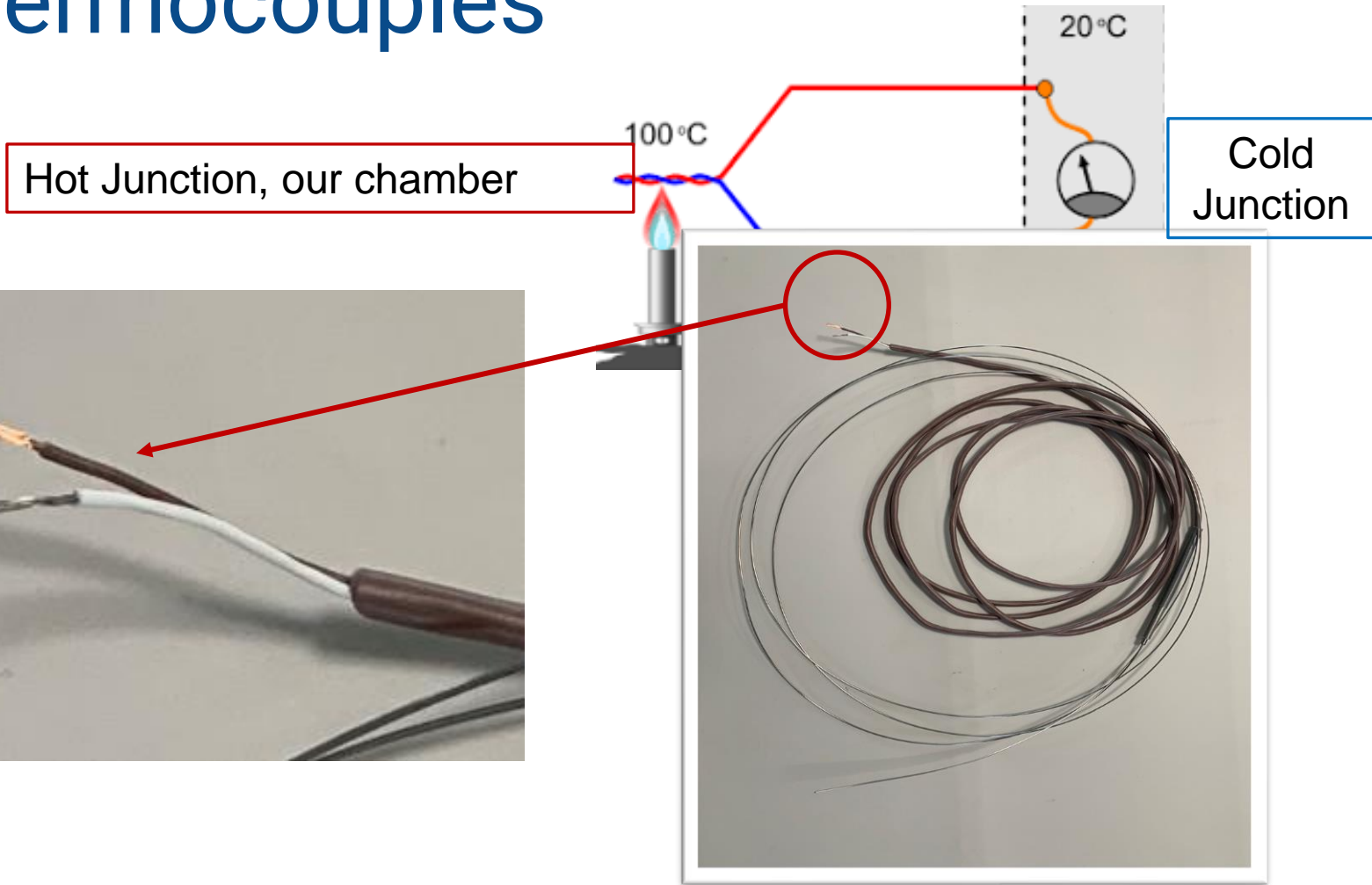
- Different accuracies of Pt 100
- Fedegari uses AA

Pt 100 certificate of compliance

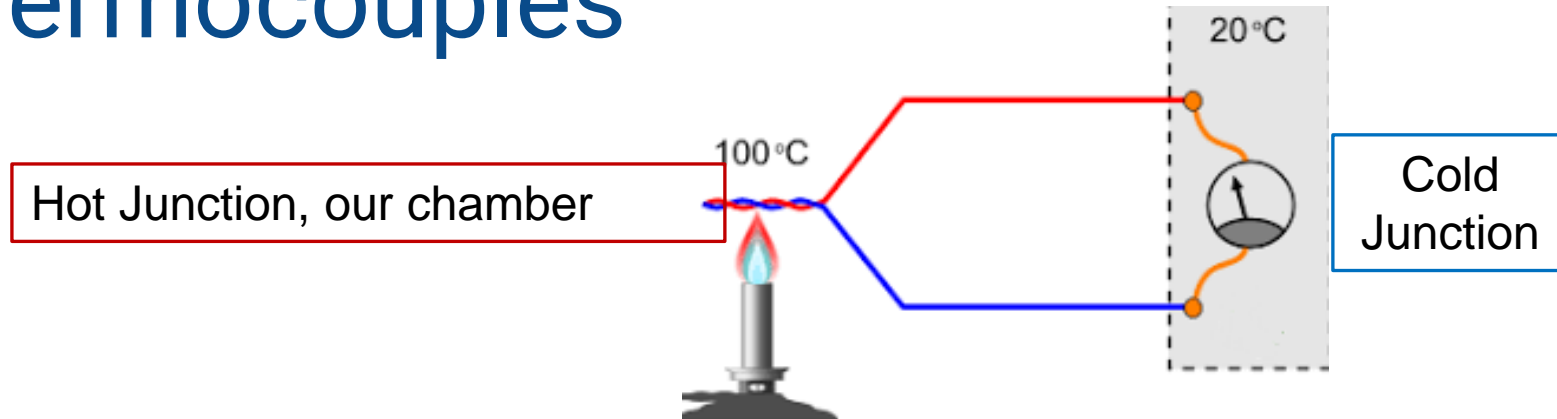
	CERTIFICATE OF COMPLIANCE	
Resistance Thermometer Device specifically produced for →		
PRODUCT IDENTIFICATION		
Drawing / Model	<input checked="" type="checkbox"/> PM600019 – RTD single element – sheath 67mm – cable 4000 mm <input type="checkbox"/> PM600083 – RTD single element – sheath 67mm – cable 7000 mm <input type="checkbox"/> PM600028 – RTD single element – sheath 67mm – cable 10000 mm	
Production batch	: 18.02478/7 Serial No. from 001 to 130	
Quantity	: 130	
Fedegari's P.O.	: 2018304212	
Certificate No.	: 00079 issued on 12-Feb-2019 (DM#335613)	
Marking	: E1907029A	
Accuracy	: according to IEC-60751:Class AA for T -50...+250°C	
STATEMENTS		
<p>The above resistance thermometers device (RTD) production batch has been manufactured by ELSI srl according to Fedegari Autoclavi Spa technical specifications. Parts and components, production processes and calibrations are made to offer the best possible product especially for the high demanded applications in Fedegari's markets. This RTD can be put into the market only by Fedegari Autoclavi Spa and its qualified support centres.</p> <p>We hereby declare the full compliance to IEC 60751, the relevant type tests are recorded by Fedegari Autoclavi Spa. Furthermore we declare metallic parts that are in contacts with the process fluids have been manufactured in stainless steel type 316L. Non metallic parts that are in contacts with the process fluids have been manufactured in biocompatible silicone and meet the US regulations FDA CFR 177.2600 and USP Class VI. Quality certificates of the above materials are recorded by Fedegari Autoclavi Spa.</p>		
ROUTINE PRODUCTION TESTS		
Test	Results	
Resistance tolerance – thermometers	OK	
Resistance tolerance – resistors	OK	
Insulation resistance at ambient temperature	OK	
Insulation resistance at 121°C	OK	
Sheath integrity test	OK	
Dimensional check	OK	
Date: 12-Feb-2019	 Alessandro Morganti Managing director ELSI srl Via Milano, 11 20020 Lainate (MI) Italy	

Thermocouples

Thermocouples

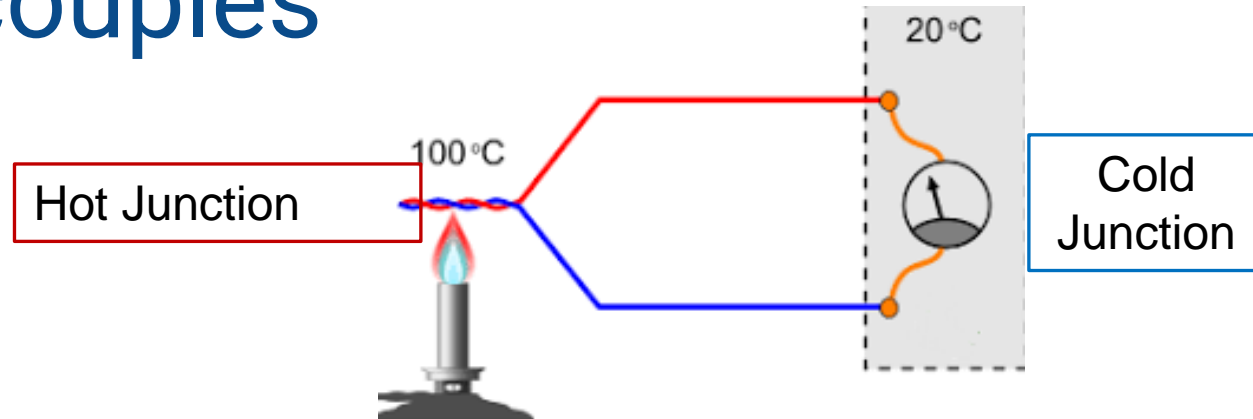


Thermocouples



- Two wires of two different metals.
- Connected at two points, the 'Hot Junction' and 'Cold Junction'.
- Heat hot junction → flow of electrons between two metals.
- Voltage is proportional to the difference in temperature between the hot and cold junction

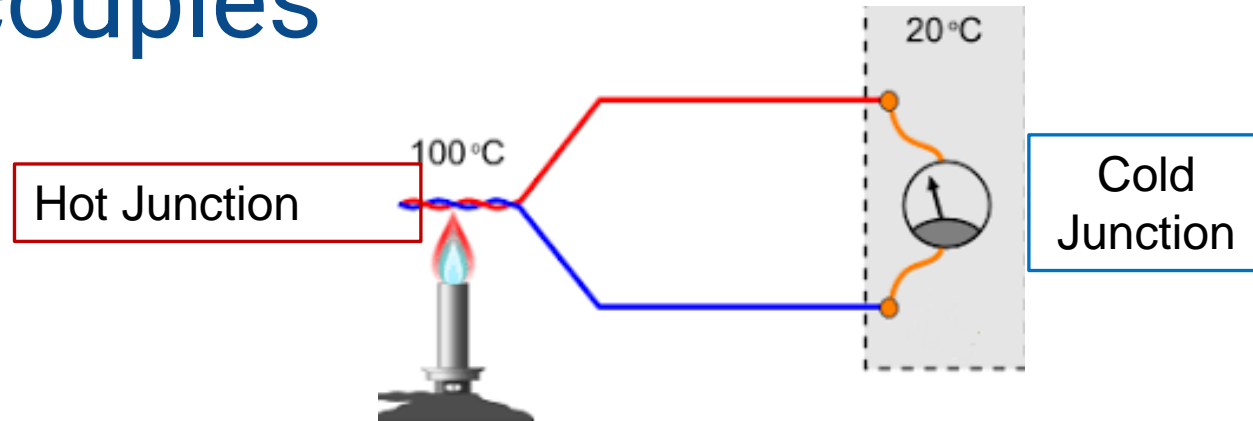
Thermocouples



Bad Points

- Calibration required before use.
- Verification required after use.
- May not hold calibration for a long time due to change in purity of metals.

Thermocouples



Good Points

- Very flexible/easily manipulated to get into load
- Can measure temperature in a very precise place
- More affordable

IEC 60584-2013

Tolerance classes for thermocouples according to IEC 60584:2013
 The American ASTM E230/E230M-12 is a parallel standard, but be aware that both tolerances and temperature ranges could be different from those of the IEC standard.
 Note that prescribed tolerances are valid for unused thermocouple material only.

Thermocouple	Tolerance class 1 (°C)	Tolerance class 2 (°C)	Tolerance class 3 (°C)
Type R and S			
Temperature range	0 ≤ T ≤ 1800	0 < T < 1800	
Largest value is to be used.	±1 för T < 1100	±1,5	-
	[±1+0,003·(T-1100)] för T > 1100	±0,0025·T	
Type B			
Temperature range		600 < T < 1700	600 < T < 1700
Largest value is to be used.	-	±1,5	±4
		±0,0025·T	±0,005·T
Type J			
Temperature range	-40 < T < 750	-40 < T < 750	
Largest value is to be used.	±1,5	±2,5	-
	±0,001·T	±0,0075·T	
Type T			
Temperature range	-40 < T < 350	-40 < T < 350	-200 < T < 40
Largest value is to be used.	±0,5	±1	±1
	±0,004·T	±0,0075·T	±0,015·T
Type E			
Temperature range	-40 < T < 800	-40 < T < 900	-200 < T < 40
Largest value is to be used.	±1,5	±2,5	±2,5
	±0,004·T	±0,0075·T	±0,0075·T
Type K and N			
Temperature range	-40 < T < 1000	-40 < T < 1200	-200 < T < 40
Largest value is to be used.	±1,5	±2,5	±2,5
	±0,004·T	±0,0075·T	±0,0075·T
Type C			
Temperature range		428 < T < 2315	
Tolerance		±0,01·T	
Type A			
Temperature range		1000 < T < 2500	
Tolerance		±0,01·T	
Reference junction 0°C			
<small>Updated 2014-09-22</small>			

- Our choice:
- Type T, Copper/ Constantan
- ✓ *T range according to our criteria*
- ✓ *Severe tolerance class*

TC: when do we use them?

Temp. Distribution Exercise
(Thermal mapping)
During OQ – empty chamber

Temp. Penetration Exercise
During PQ – with the load for cycle development

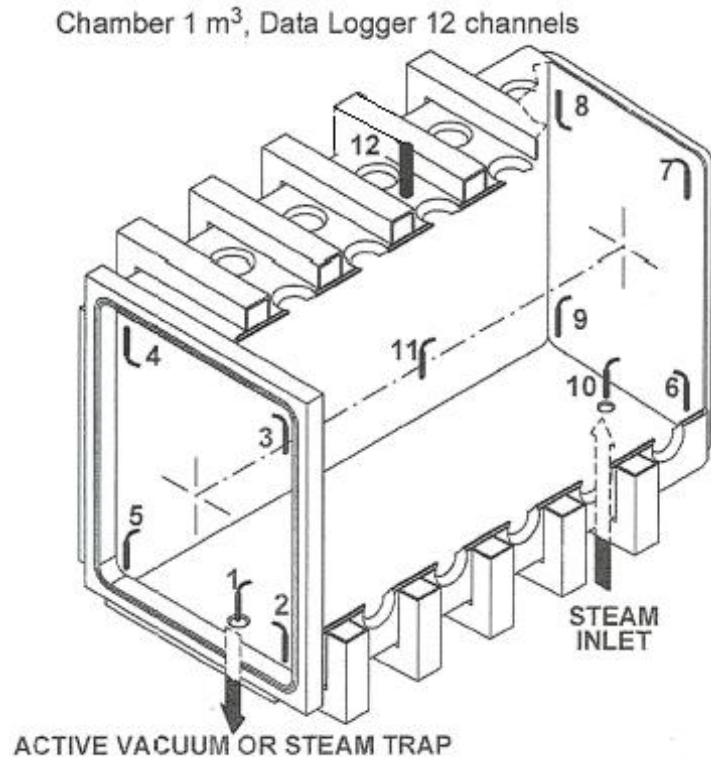
TC – FAQ how many have to be used?

- There are not set rules
- Must be judged on a case by case basis
- Enough to cover all critical points within chamber and load
- Typical 'rule of thumb'
 - 12 for all chambers up to 2000 liters.
 - Plus two for every extra 1000 liters

TC – FAQ where locating them?

- There are not set rules
- Looking for the coldest point during the exposure
- Looking for the slowest point to reach minimum Sterilization temperature
- Enough to cover all critical points within chamber and load

TC – FAQ where locating them?



Summary

	Pt 100	Thermocouple
How they work?	Resistance across a platinum resistor	Voltage created between two wires of different metals
When do we use them?	Sterilization process control	OQ and PQ procedures for thermal distribution and thermal penetration
Good points	Hold calibration well Robust	Easily manipulated Measure temp in a precise point
Bad Points	Large and harder to manipulate	Have to frequently recalibrate

Thank you

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