# POWER

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#### Power

- There are several considerations in determining power requirements for thermistors -
  - How much power a thermistor can dissipate without damage to the thermistor and
  - How much power a thermistor can dissipate and maintain accuracy

# Safe Power Dissipation

- The maximum power YSI thermistors can safely dissipate depends on the thermistor type-
  - YSI 44000 series can dissipate 30mW @ 25°C derated to 1mW @125°C (short term)
  - YSI 55000 series can dissipate 30mW @ 25°C derated to 1mW @125°C (short term)
  - YSI 45000 and 46000 series can dissipate 50mW @
     25°C derated to 2mW @125°C (short term)

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Safe Power Dissipation - cont

For temperatures between 25 and 125°C, use linear interpolation to obtain mW/°C

 $30\mathrm{mW} - 1\mathrm{mW} = 29\mathrm{mW}$ 

 $125^{\circ}C - 25^{\circ}C = 100^{\circ}C$ 

 $29 \text{mW} / 100^{\circ}\text{C} = .29 \text{mW} / ^{\circ}\text{C}$ 

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# Safe Power Dissipation - cont

- Adjust target temperature (T) to dissipation temperature range (25 to 125°C)
- Multiply adjusted temperature (T<sub>adj</sub>) by .29mW/°C
   Add mW<sub>Tadj</sub> to 30mW to get the power dissipation (P<sub>D</sub>)

$$T_{adj} = (25^{\circ}C - T)$$
$$mW_{T_{adj}} = 0.29mW / {^{\circ}C} \times T_{adj}$$
$$P_{D} = 30mW + (mW_{T_{adj}})$$

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# Safe Power Dissipation - cont

For example, the power dissipation for a YSI 44000 series thermistor at 62°C is 19.3mW

 $-37^{\circ}C = 25^{\circ}C - 62^{\circ}C$ 

 $-10.73mW = \frac{0.29mW}{\circ C} \times (-37^{\circ}C)$ 

19.27mW = 30mW + (-10.73)mW

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## Power Dissipation and Accuracy

To understand how power dissipation affects accuracy, we need to understand dissipation constant and self-heat

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**Dissipation Constant** 

- Dissipation Constant is the power required to raise the temperature of a thermistor 1°C above its ambient temperature
- The dissipation constant is a function of the surface area of the thermistor, the greater the surface area the larger the dissipation constant
  - The thermistor environment and thermal characteristics of material also heavily influence the dissipation constant

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# Dissipation Constant - cont

- Dissipation constants for the YSI thermistor types
  - YSI 44000 series dissipation constant is 8mW/°C in well-stirred fluid and 1mW/°C in air
  - YSI 55000 series dissipation constant is 6mW/°C in well-stirred fluid and 1.5mW/°C in air
  - YSI 45000 and 46000 series dissipation constant is 10mW/°C in well-stirred fluid and 4mW/°C in air

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# Self-Heat

- When the power applied to the thermistor is greater than what the thermistor can dissipate, the thermistor 'heats-up' and changes resistance
- YSI thermistors are 'NTC' or negative temperature coefficient devices, as the power increases, the resistance decreases
- If this change in resistance is unintentional (some applications utilize thermistor self-heat properties), then you have self-heat error

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#### Self-Heat Error

To determine the maximum power you can apply and not exceed a specified self-heat error, use

#### $P = D \bullet \Delta T$

 where P is applied power in mW, D is dissipation constant in mW/°C, and T is maximum allowable selfheat error

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Self-Heat Error - cont

## Example

To limit self-heat error to less than .05°C for a YSI 44000 series thermistor used in air

 $P = 1mW / {}^{\circ}C * .05 {}^{\circ}C P = .05mW = 50\mu W$ 

 No more than 50uW of power can be applied and not exceed .05°C self-heat error

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# Conclusion

- These are the basic principles used for determining the power requirements for thermistors
- If you need additional information, please contact YSI Precision Temperature Group at 800-747-5367 or 937-427-1231 option 1

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