Proper installation of temperature sensors in biomass boiler systems

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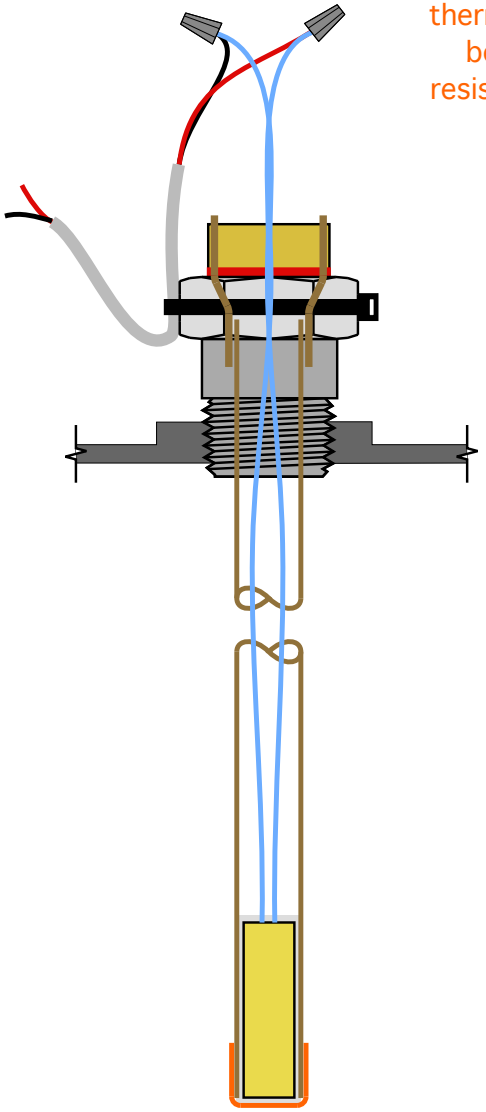
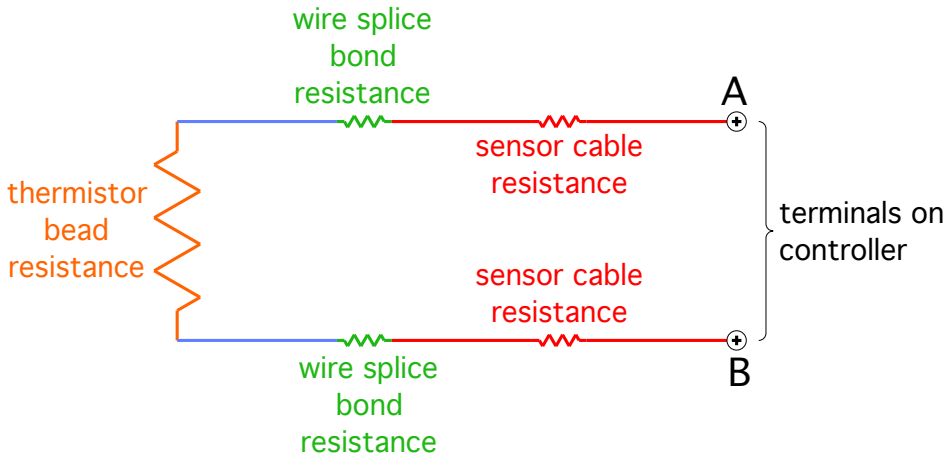




February 18, 2021
1:00 PM

Moderated by:

Sue Dougherty
Clean Heating & Cooling program
NYSERDA
sue.dougherty@nyserda.ny.gov

presented by:

John Siegenthaler, P.E.
Principal, Appropriate Designs
Holland Patent, NY
www.hydronicpros.com

Proper installation of temperature sensors in biomass boiler systems

Session description: Improper temperature sensor placement can drastically limit the performance of both pellet boiler and cordwood gasification boilers. This webinar will show examples of incorrectly placed sensors based on field experience. It will also show correct mounting and wiring methods for both surface-mounted and well-mounted sensors.

Learning objectives:

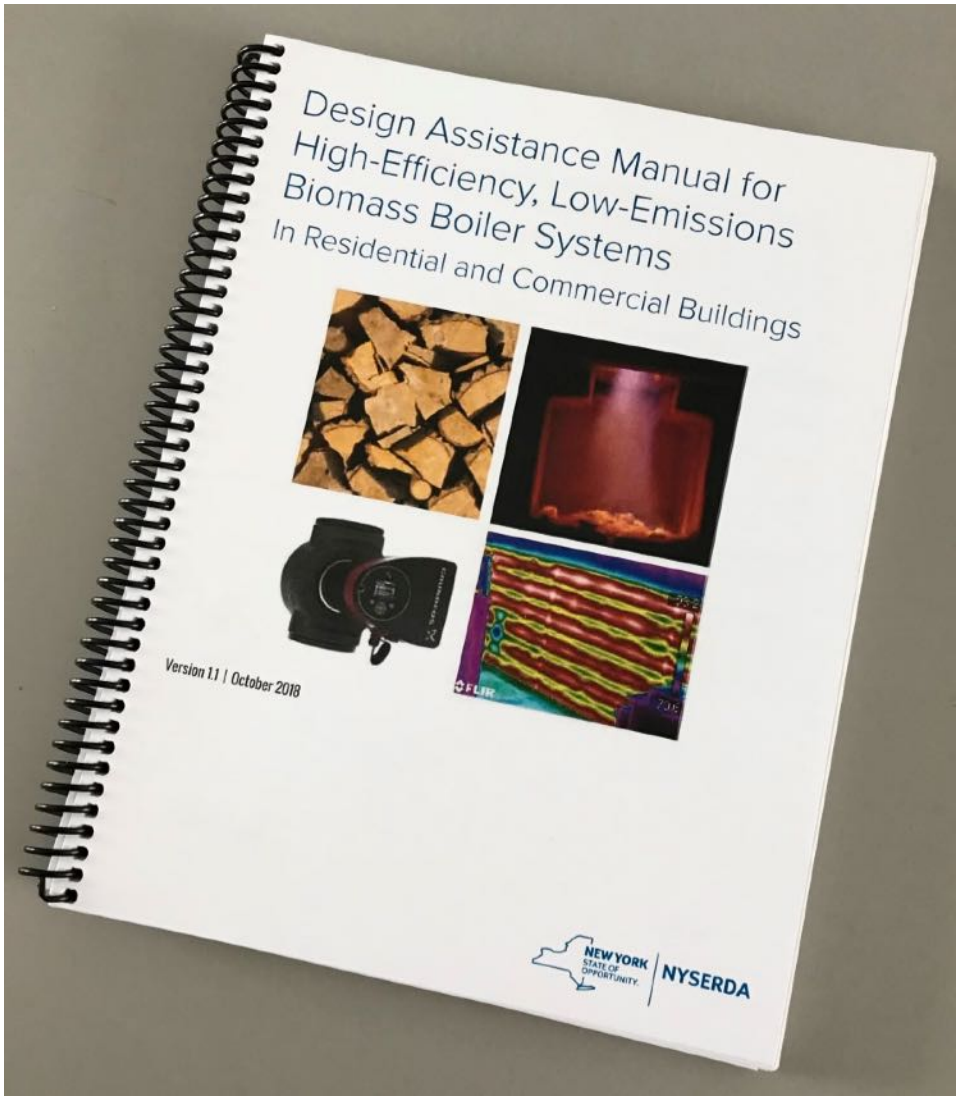
1. Understand how thermistor sensors work.

2. Explain the importance of the overall sensor **circuit**.

3. Understand consequences of improperly mounted sensors.

4. Understand how to construct a temperature sensor well.

Design Assistance Manual
for High Efficiency Low Emissions Biomass Boiler Systems



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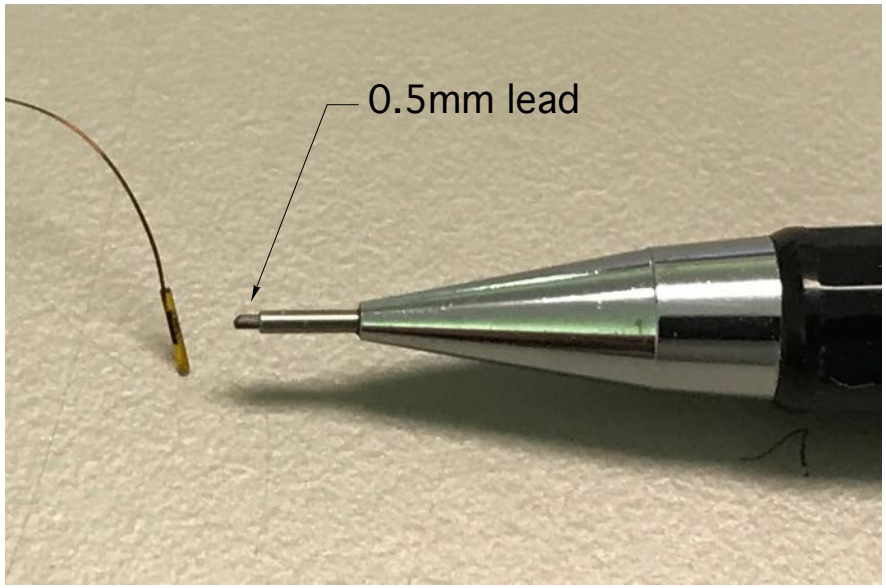
It's available as a FREE downloadable PDF at:

https://www.nyserda.ny.gov/-/media/Files/EERP/Renewables/Biomass/Design-Assistance-Biomass-Boiler.pdf

Thermistor sensors & circuits

Thermistor sensors

Electrical resistance of the sensor varies as its temperature changes.



The sensor bead is very small (50 AWG “thread-like” wires) Totally impractical to work with in field conditions.

The sensor bead is bonded to larger wiring, then “potted” into a copper capsule.

Note the “saddle” on the capsule that’s designed to fit the curved surface of a tube.

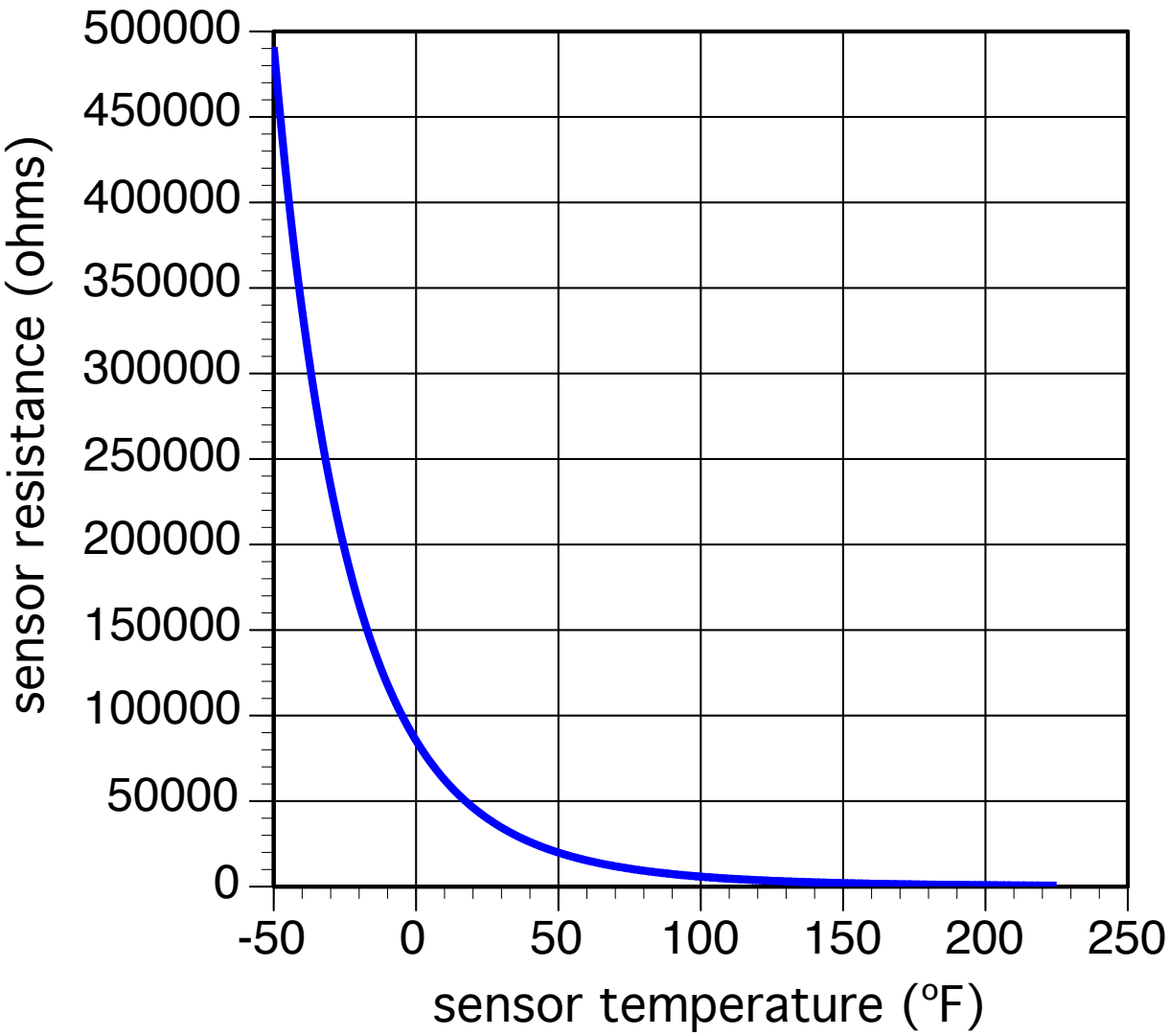
Thermistor sensors

Electrical resistance of the sensor varies as its temperature changes.

The graph is for a NTC (negative temperature coefficient) thermistor that has **10K ohm resistance at 25C (77°F).** This is a common type used in HVAC systems.

The resistance is very non-linear (large changes in resistance at low temperature, small changes at higher temperatures.

The resistance vs. temperature curve is very repeatable.

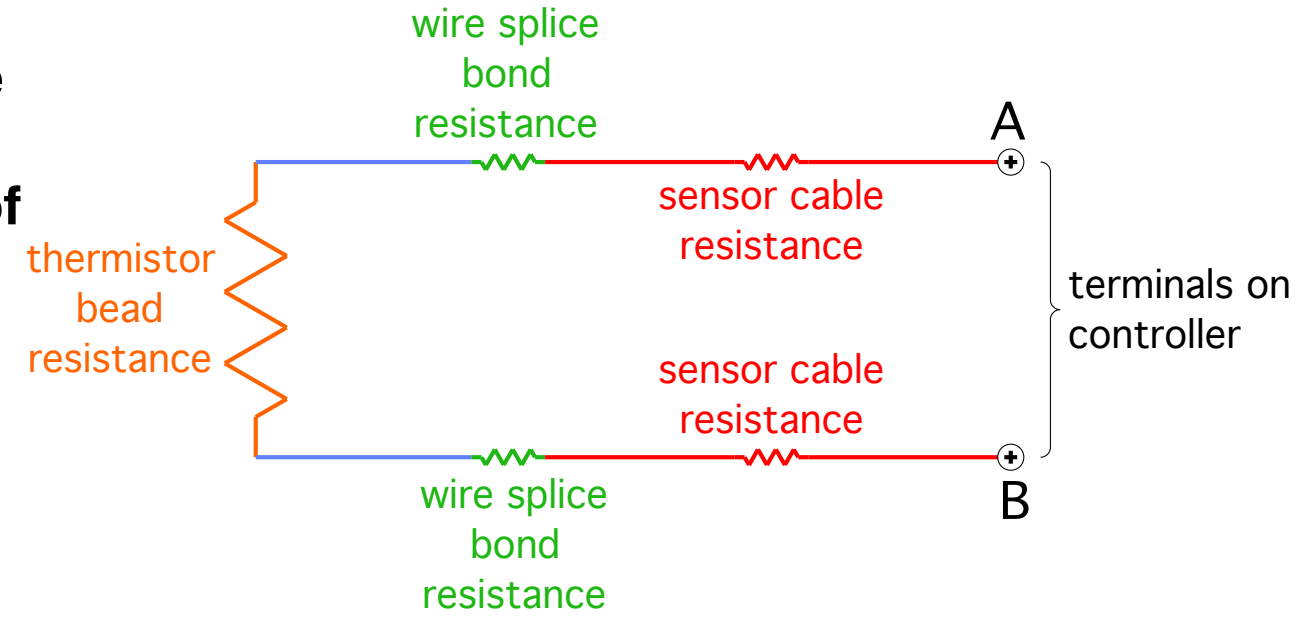


Thermistor sensor circuits

The controller “feels” the full resistance of the sensor circuit.

The objective is to make the resistance of the sensor circuit almost entirely that of the thermistor bead.

This requires the resistance of the wire splice and sensor cable to be very low.



#18 AWG copper wire has a resistance of 0.0064 ohms/ft

Assuming 500 total feet of #18 AWG copper wire, the sensor cable resistance would be 3.2 ohms

The sensor cable resistance would only be 0.03% of the circuit resistance assuming the thermistor bead is at 10K ohm, and that the wire splice resistance is 0. This is fine for HVAC applications.

When using controllers with thermistor sensors always verify the manufacturer’s maximum sensor cable length, AND minimum wire size

I suggest nothing smaller than #18 AWG copper

Thermistor sensor circuits

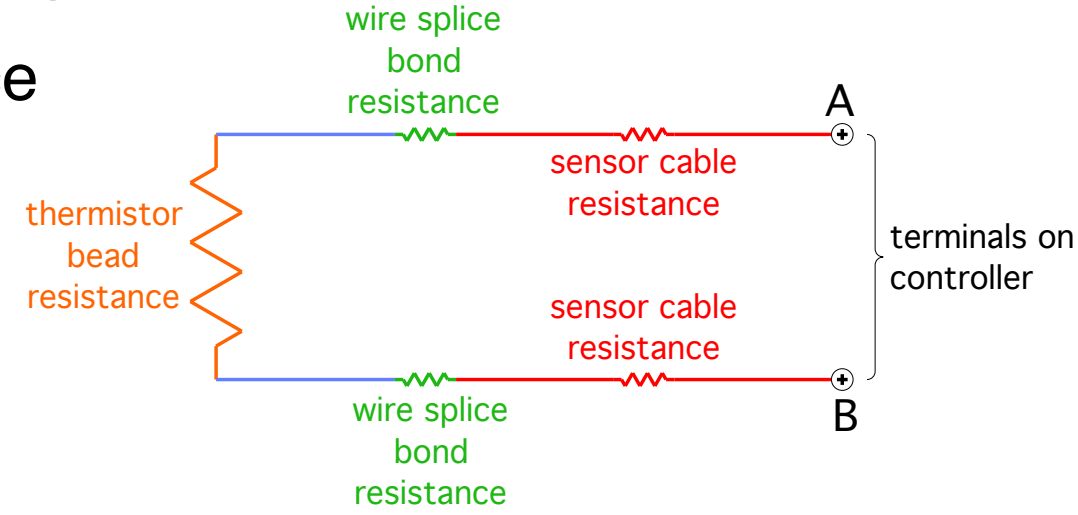
sensor wire splice bond resistance

It's very import to make the wire splice resistance as low as possible.

The ideal bond is by soldering - although seldom done in field.

When using mechanical connectors it is crucial to keep moisture away from the bond.

Moisture within the connector will eventually cause oxidation, which increase bond resistance

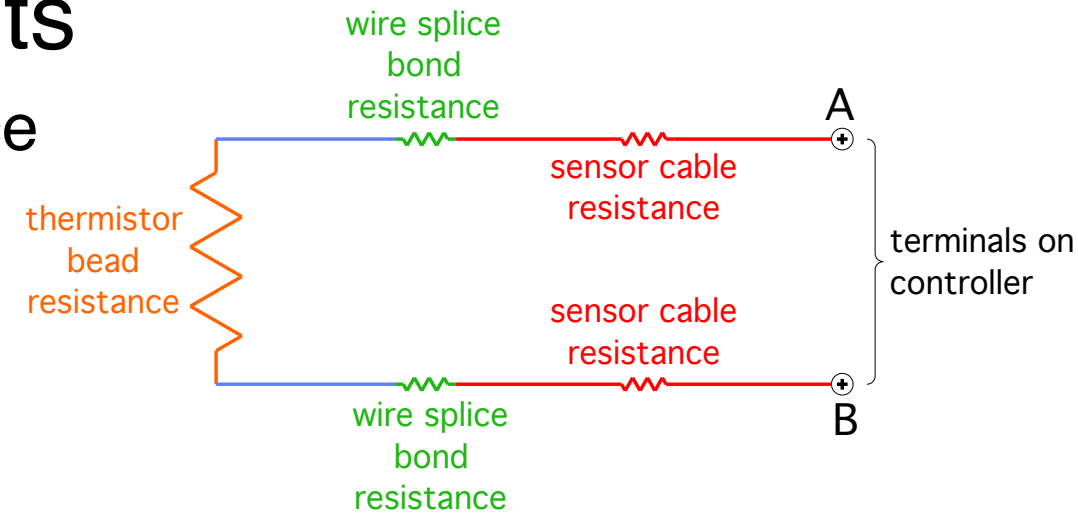


Avoid wire nuts in any location where moisture could reach the bond

Wrapping a wire nut connection with electrical tape will not prevent moisture entry (condensation)

Thermistor sensor circuits

sensor wire splice bond resistance



The preferred type of connector is a gel-filled splice connector (extensively used in telephone cable splicing)

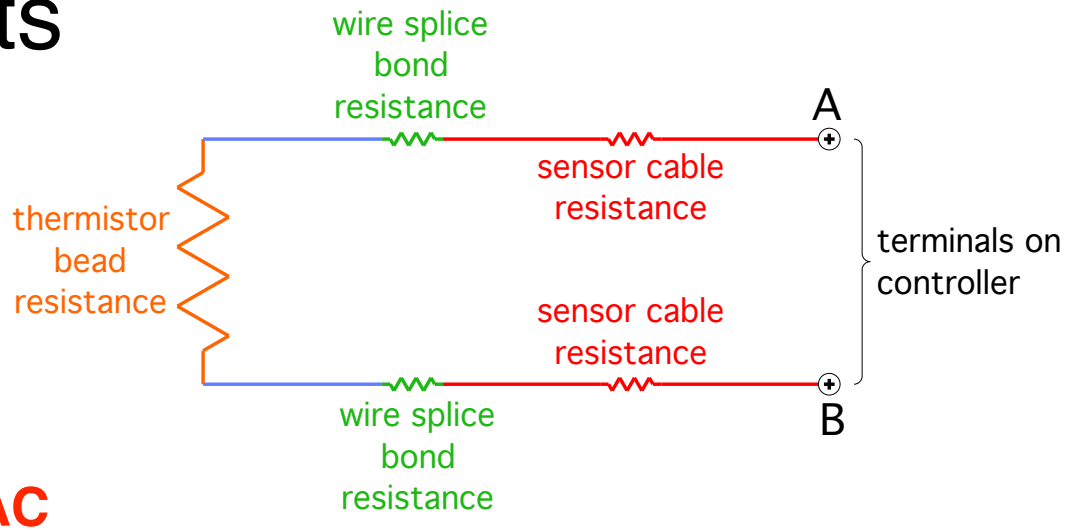
The two lead do not need to be stripped. Just push them all the way into connector (into the insulating gel)

press down the “button” at top of connector. This causes an internal metal blade to piece the insulation on the wires and make the bond.

If doing lots of these invest in a special pliers. If not so many - just use a utility pliers

Thermistor sensor circuits

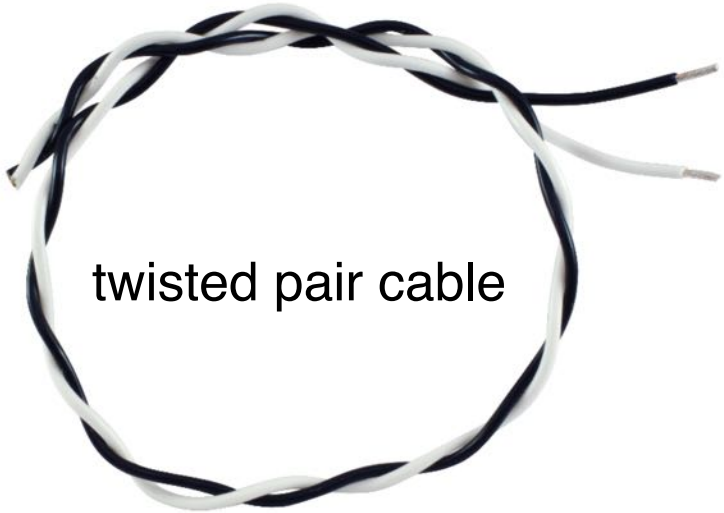
sensor cable types



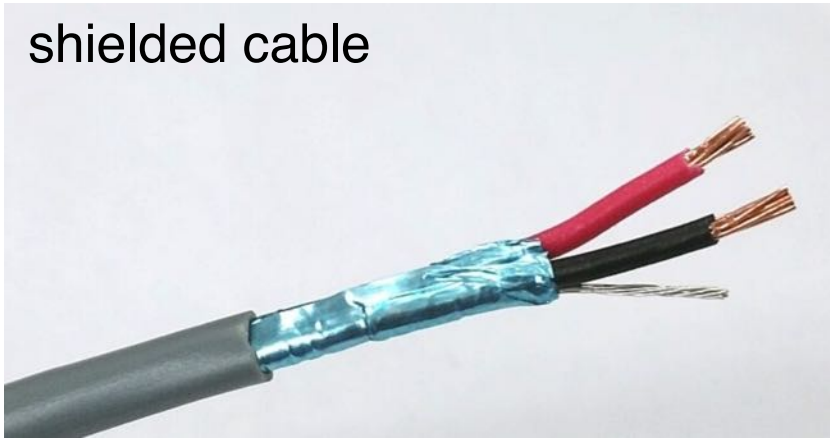
In many locations it's possible to use #18 AWG copper thermostat cable for sensor wiring.

Do not route this wiring parallel with AC wiring. (It's possible for the AC signal to induce a current in the sensor cable) EMI

If routing sensor cables near motors or florescent lights it's best to use either **twisted pair** wiring or **shielded cable**.

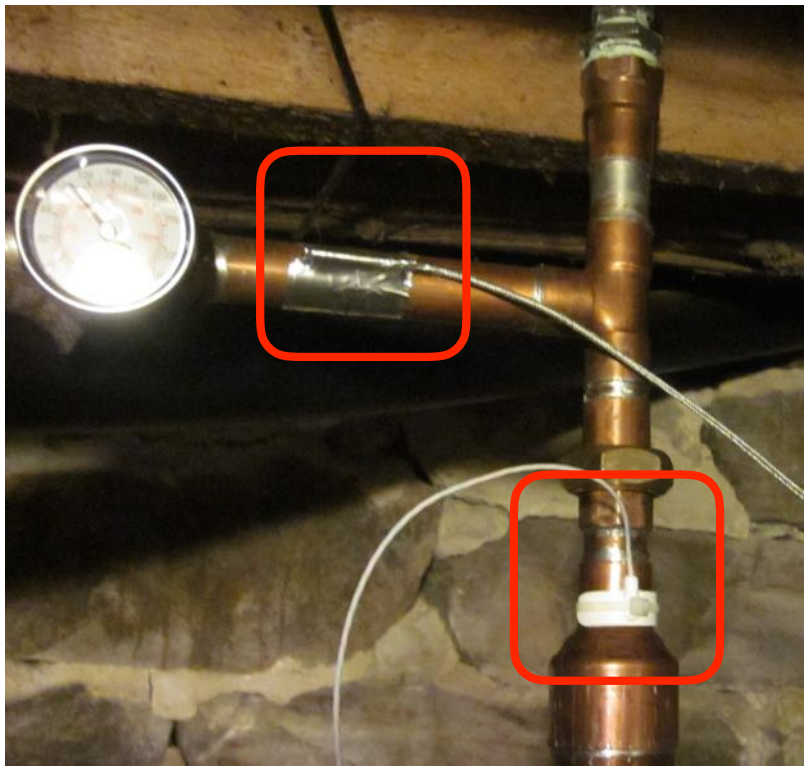


When shielded cable is used the grounding jacket (& wire if present) should only be connected to ground at **one end** of the cable.

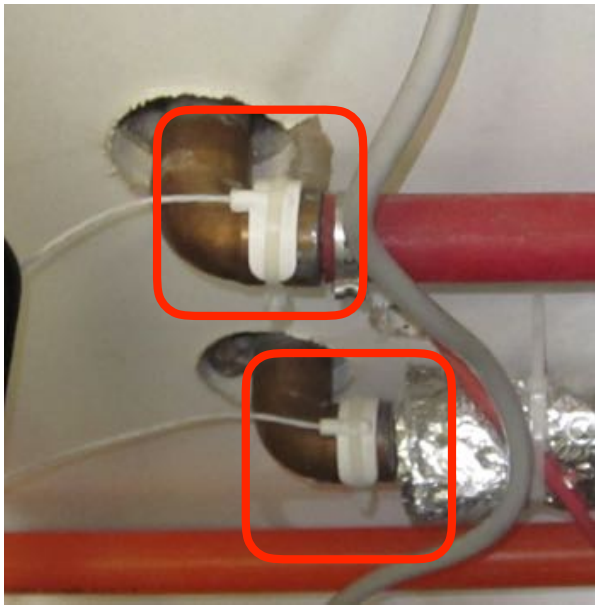


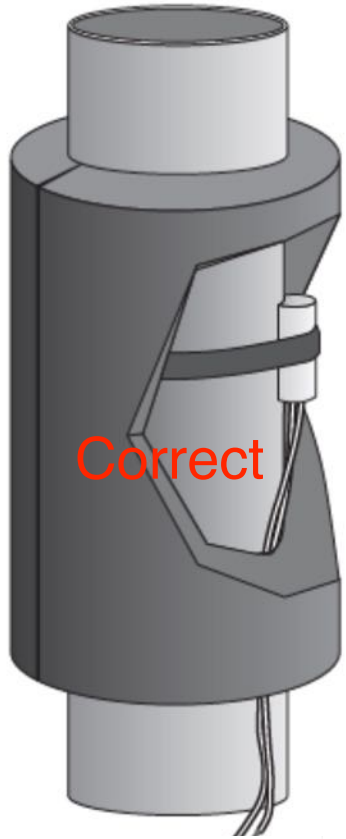
Poor temperature sensor placement

If a controller can't "feel" the temperature, it can't control that temperature…



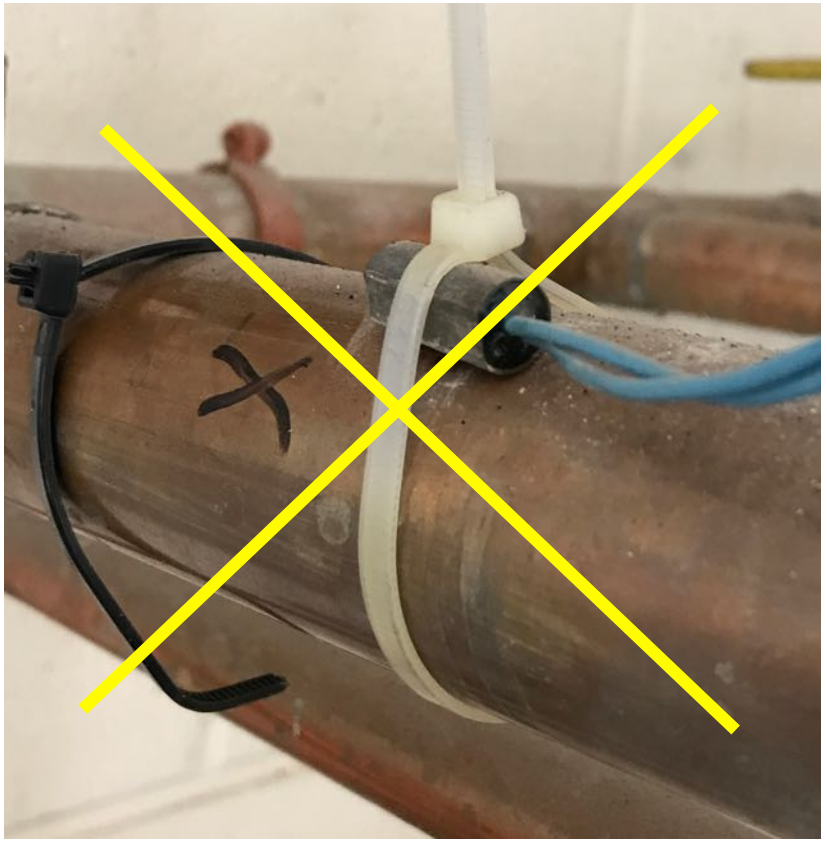
non-insulated surfaced mounted temperature sensors





Some sensors have a concave shape to fit OD of pipe.

Poor sensor placement or lack of insulation



Pipe-mounted sensor with sealed insulation jacket

Temperature sensors in wells

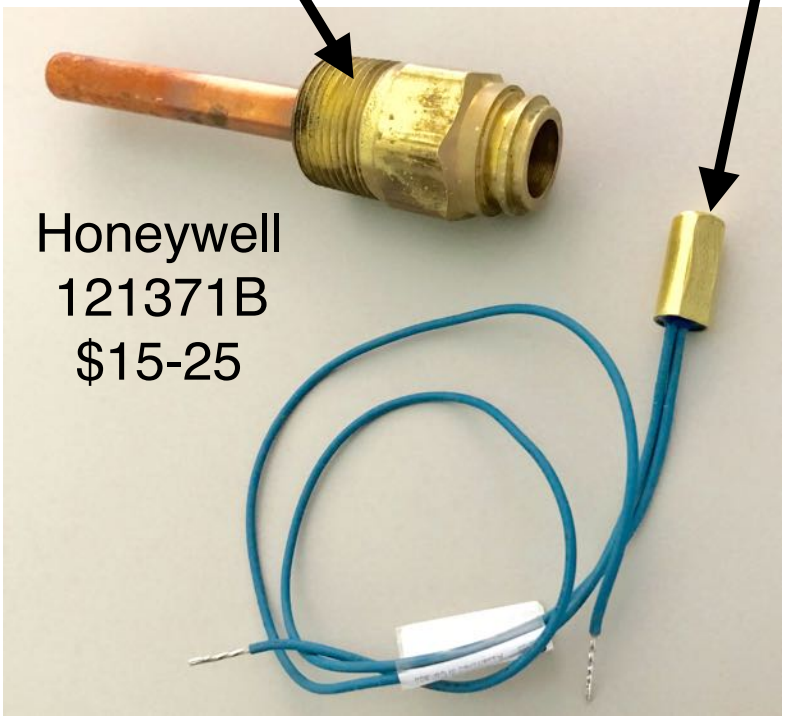
Temperature sensors mounted in wells

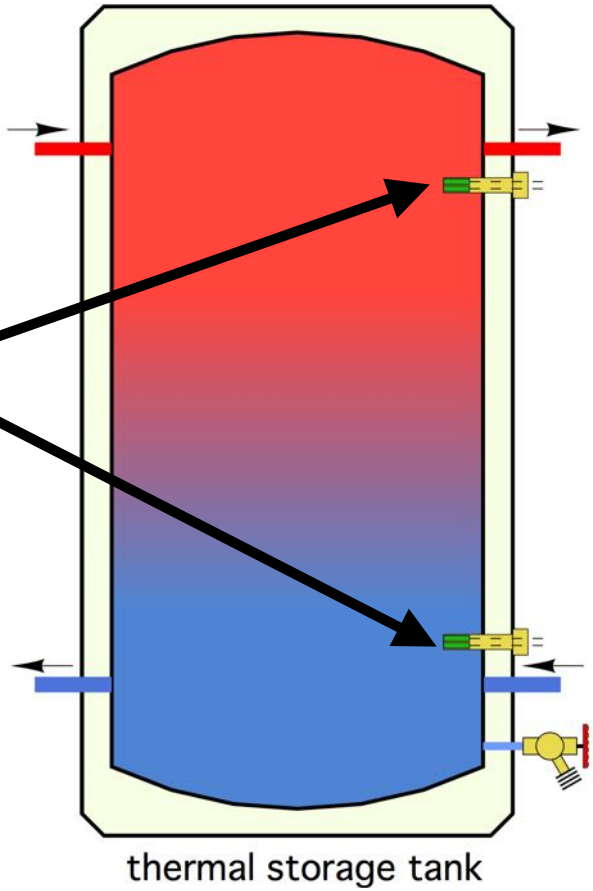
When measuring the temperature within heat sources, or thermal storage tanks mount the sensor in a well.

Honeywell 121371B available in either 1/2” or 3/4” MPT threads

3/8” OD sensor is excellent fit into Honeywell well

sensors in wells



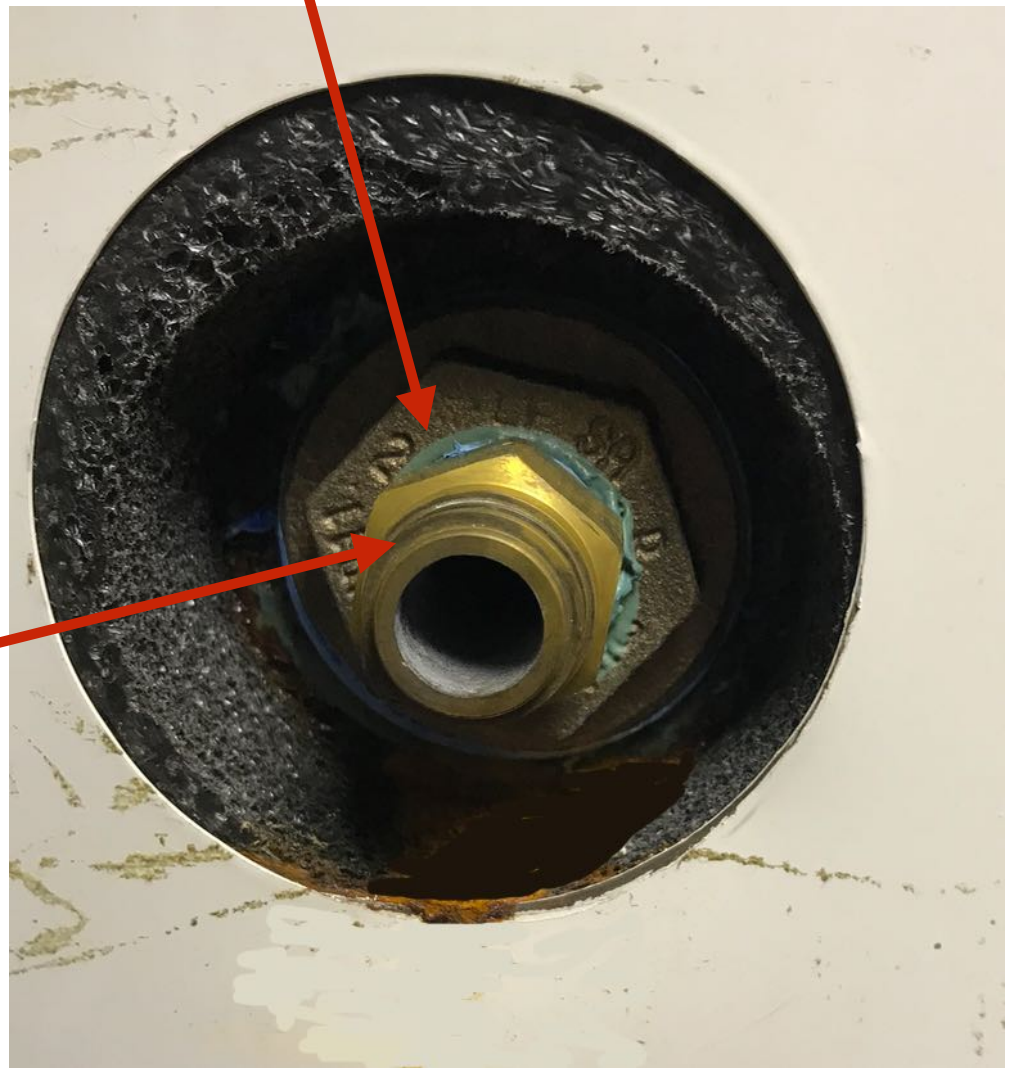


Temperature sensors mounted in wells

Use 2” MPT x 3/4” FPT stainless steel or brass bushings to mount sensor well to larger connections on tank.

Honeywell 121371B
well with 3/4” MPT threads

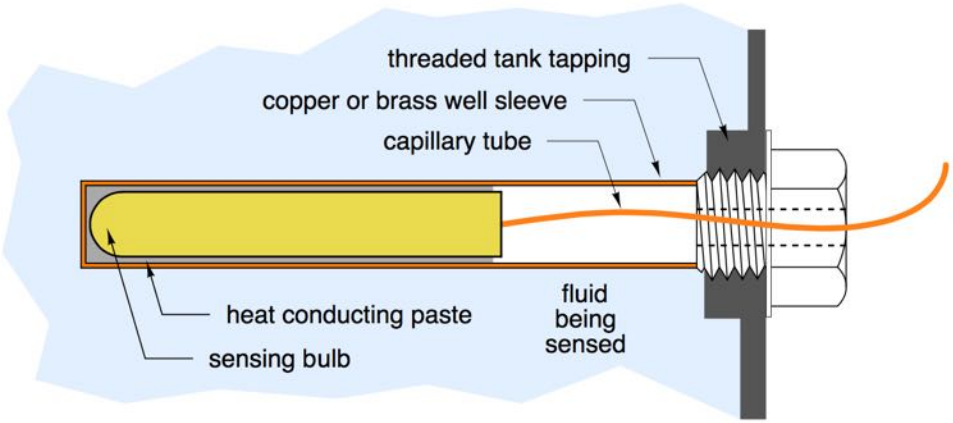
2” MPT x 3/4” FPT bronze bushing
(installed with large socket wrench)



Poor sensor placement or lack of insulation

Thermal grease is readily available (online). It's often used to bond microprocessors to heat sinks.

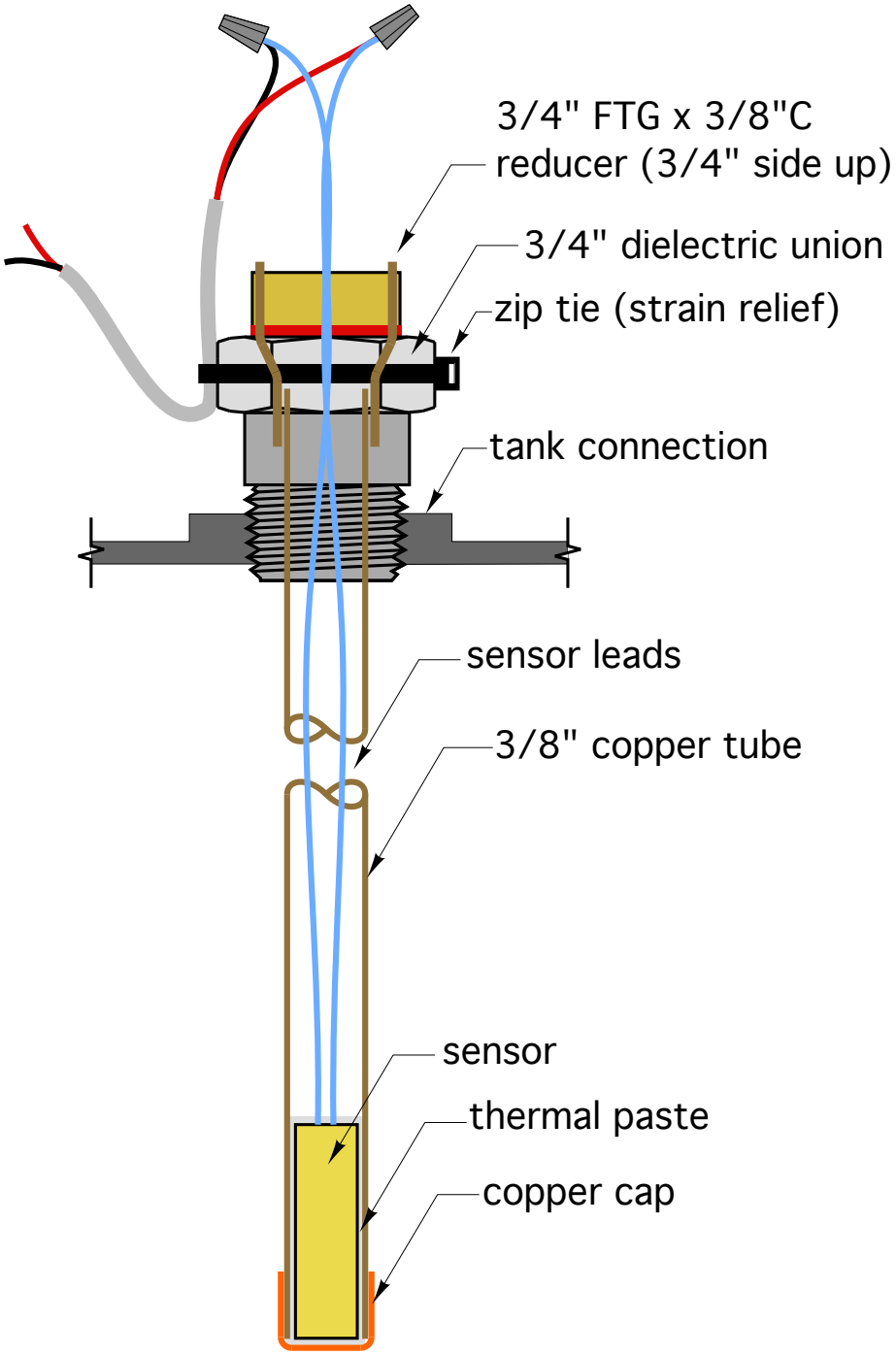
Thermal grease
in syringe:
$7, eBay

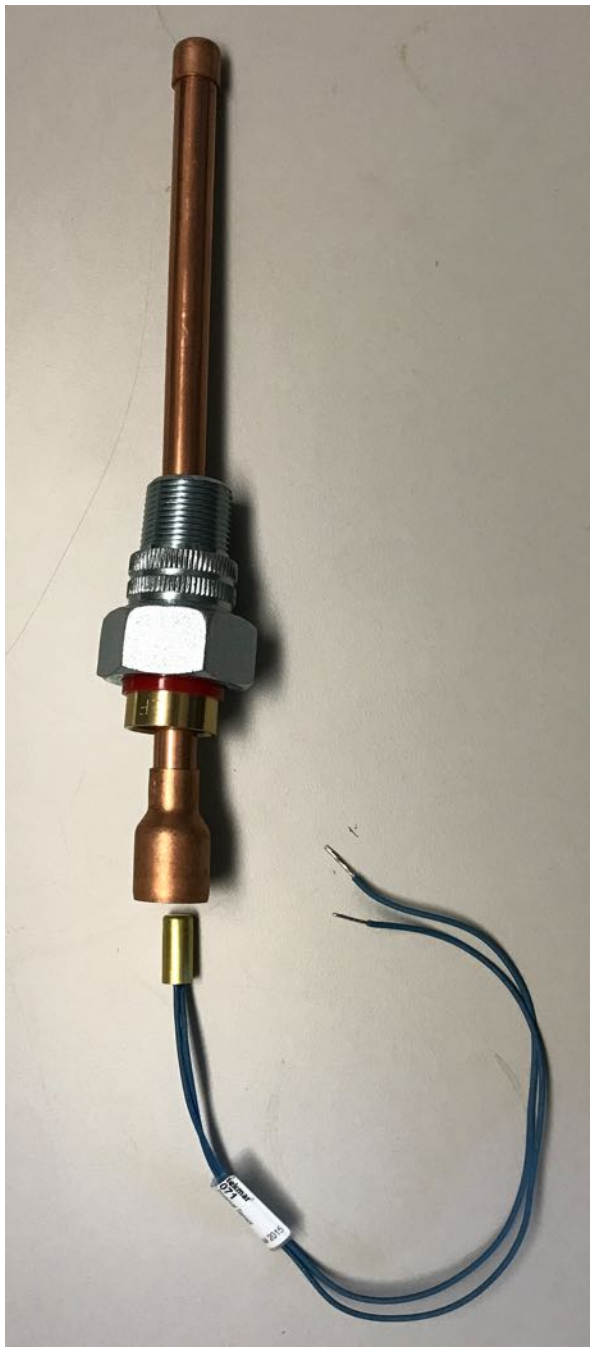


Use a small tube attached to syringe to get the grease down to the end of the sensor

Building a sensor well

Simple way to built a sensor well





RHNY Incentives

<table>
<tr><th>Program</th><th>System Type</th><th colspan="2">Installation Incentive</th><th colspan="3">Additional Incentive</th></tr>
<tr><td rowspan="4">Small Biomass Boiler</td><td>Advanced Cordwood Boiler with Thermal Storage</td><td colspan="2">25% installed cost ($7,000 maximum)</td><td>-</td><td rowspan="5">Recycling

$5,000/unit for old indoor/ outdoor wood boiler
<u>or</u>
$2,500/unit for old wood furnace</td><td>-</td></tr>
<tr><td rowspan="2">Small Pellet Boiler with Thermal Storage</td><td>≤120 kBtu/h (35 kW)</td><td>45% installed cost ($16,000 maximum)</td><td rowspan="3">Thermal Storage Adder

$5/gal for each gal above the minimum thermal storage requirement</td><td>-</td></tr>
<tr><td>≤300 kBtu/h (88 kW)</td><td>45% installed cost ($36,000 maximum)</td><td>-</td></tr>
<tr><td rowspan="2">Large Pellet Boiler with Thermal Storage</td><td rowspan="2">>300 kBtu/h (88 kW)</td><td>65% installed cost ($325,000 maximum)</td><td rowspan="2">Emission Control System

$40,000</td></tr>
<tr><td>Large Biomass Boiler</td><td>Tandem Pellet Boiler with Thermal Storage</td><td>75% installed cost ($450,000 maximum)</td></tr>
<tr><td>Residential Pellet Stove</td><td>Pellet Stove</td><td colspan="2">$1,500 ($2,000 for income qualified residents)</td><td>-</td><td>Recycling

$500 (income qualified residents only)</td><td>-</td></tr>
</table>

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LMI Incentives - Boilers

Program	System Type		Market Rate Installation Incentive	LMI Installation Incentive
Small Biomass Boiler	Advanced Cordwood Boiler with Thermal Storage		25% installed cost ($7,000 maximum)	65% installed cost ($18,000 maximum)
	Small Pellet Boiler with Thermal Storage	≤120 kBtu/h (35 kW)	45% installed cost ($16,000 maximum)	65% installed cost ($23,000 maximum)

For more information:

- "Google" Renewable Heat NY
- contact Sue Dougherty at NYSERDA sue.dougherty@nyserda.ny.gov

NEW YORK STATE OF OPPORTUNITY. NYSERDA

Spring 2021 online training opportunities

January 28, 2021 / 1:00-2:00 PM

Topic: Why low temperature distribution systems improve biomass boiler performance

Description: This webinar will describe how low temperature distribution systems allow a winder range of operation for thermal storage, and how this translates to longer / more efficient and lower emission burn cycles for a pellet boiler. It will also compare control methods for enabling pellet boiler operation when the thermal storage tank can no longer sustain the heating load.

February 18, 2021 / 1:00-2:00 PM

Topic: Proper installation of temperature sensors in biomass boiler systems

Description: Improper temperature sensor placement can drastically limit the performance of both pellet boiler and cordwood gasification boilers. This webinar will show examples of incorrectly placed sensors based on field experience. It will also show correct mounting and wiring methods for both surface-mounted and well-mounted sensors.

March 18, 2021 1:00-2:00 PM

Topic: Using external heat exchangers in biomass boiler systems with non-pressurized thermal storage.

Description: Many cordwood gasification systems use unpressurized thermal storage tanks. A common approach is to use coiled copper tube heat exchangers suspended within these tanks. An alternative approach uses external brazed plate stainless steel heat exchangers. This webinar exams the advantages of the latter approach. It also shows how a single external heat exchanger can be used for both heat input to the thermal storage and heat extraction.

All training is provided free

Register here:

https://www.nyserda.ny.gov/All-Programs/Programs/Become-a-Contractor/Renewable-Heating-and-Cooling/Renewable-Heat-NY-Contractors

QUESTIONS ?