UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

DIY Outside Air Exchange

In colder climates winter storage crops have been stored in passive root cellars for centuries. Although modern refrigeration systems are generally used for large scale, longer-term storage of these crops some enterprises seek lower cost and high energy efficiency options. Outside air exchange systems use an exchange fan to draw colder outside air into a storage room to maintain a depressed temperature. The control of this requires monitoring outside temperature and inside temperature and only allowing air exchange when the outside air temperature is low enough to cool the room, but also only when the inside room requires cooling.

This control can be accomplished with two thermostats wired in series; one setup for heating (outside/colder air) and one setup for cooling (inside/room/warmer air). All thermostats are essentially a switch whose state (on or off) is controlled by a temperature sensor and a setpoint. They are either purchased or configurable for heating (turn on the load at or below a setpoint temperature) or cooling (turn on the load at or above a certain load). In our case, we are using a heating thermostat "cascaded" to a cooling thermostat so that our "load" (fan) only comes on at or below a certain oustide temperature **and** at or above a certain inside room temperature.

In this system (a mockup used for cold storage workshop instruction) I used the following items:
QTY 1 - Standard Light Switch - $0.69
QTY 1 - Switch Box - $0.91
QTY 2 - Johnson Control A419 Thermostats (link is external) w/ 6.5 ft probe (one setup for cooling, one setup for heating) - $58.95 each ($117.90 total)
QTY 1 - 70 CFM Bathroom exhaust fan (link is external) - $29.97
Misc 3 and 4 conductor 14 AWG solid wire.

Total parts: $149.47.
Total time about 2 hours for first build.

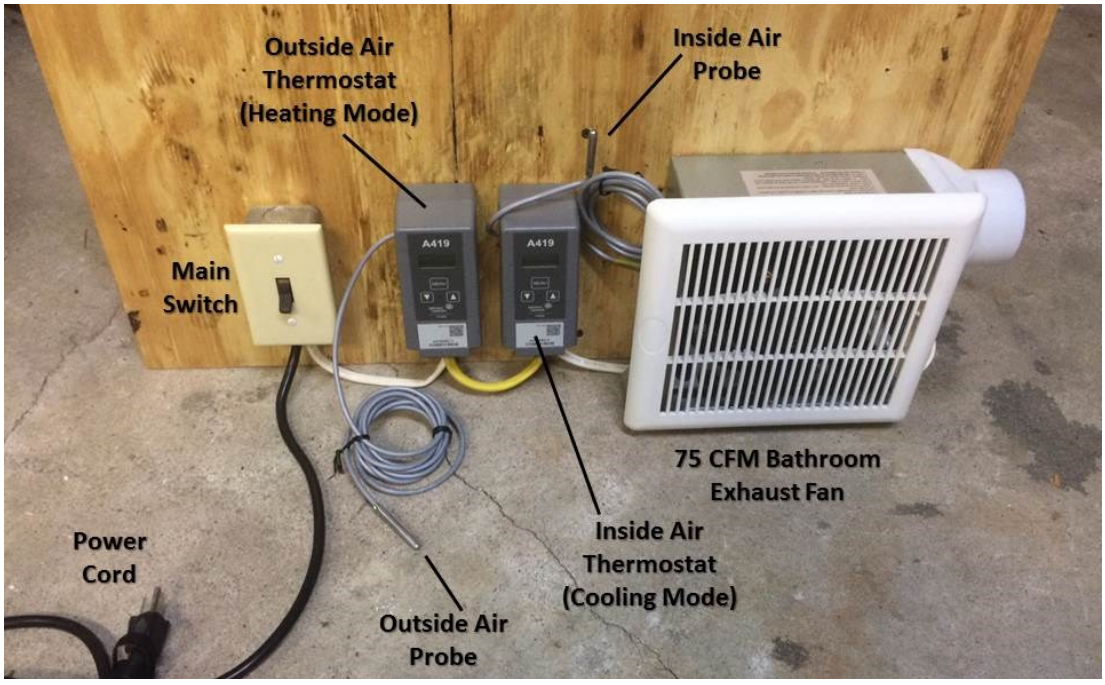
A note on thermostats. I like a digital thermostat with a remote probe and I tend to use the Johnson Control A419. It has a 1 degF setpoint resolution and down to 1 degF differential. Each one can be setup for heating or cooling by making the proper adjustment of dip switches inside the box (see p.7 of the manual). Ranco make a similar thermostat in their ETC line. I'm still on the lookout for a good, inexpensive delta thermostat (a thermostat that controls a load based on a true delta-T, or temperature difference, between two locations.) Most are designed for solar hot water systems and don't seem to allow for control at lower temperatures. And they are fairly expensive.

I ran mainly 3 conductor wire in this setup, but did find the 4 conductor wire to be a clean way of getting an additional wire from the first thermostat to the second. This allows for both thermostats to be powered regardless of the output state of the first. This lets the user see both measured temperatures and make setpoint adjustments since both thermostats are always powered whenever the main power switch is on.

The basic settings for each thermostat in this setup were:

	Outside Air Thermostat	Inside Air Thermostat
Jumper 1	JUMPED (Heating)	OPEN (Cooling)
Jumper 2	OPEN (Cut In at SP)	OPEN (Cut in at SP)
SP (Set Point)*	35 degF	40 degF
Diff (Differential)	1 degF	1 degF
ASD (Anti Short Cyle Delay)	1 min	1 min
OFS (Offset for BIN)	0 - Not used	0 - Not used
SF (Sensor Failure Operation)	0 (De-energize)	0 (De-energize)

Also available online at http://farmhack.org/tools/outside-air-exchange-control.



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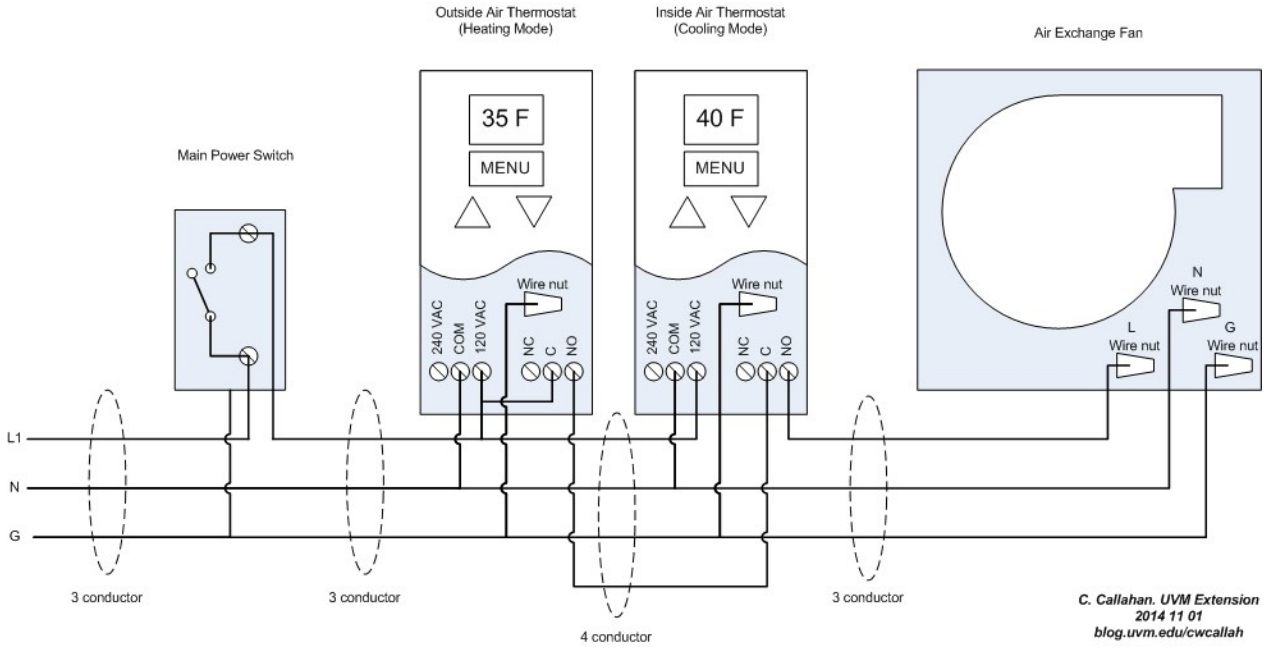
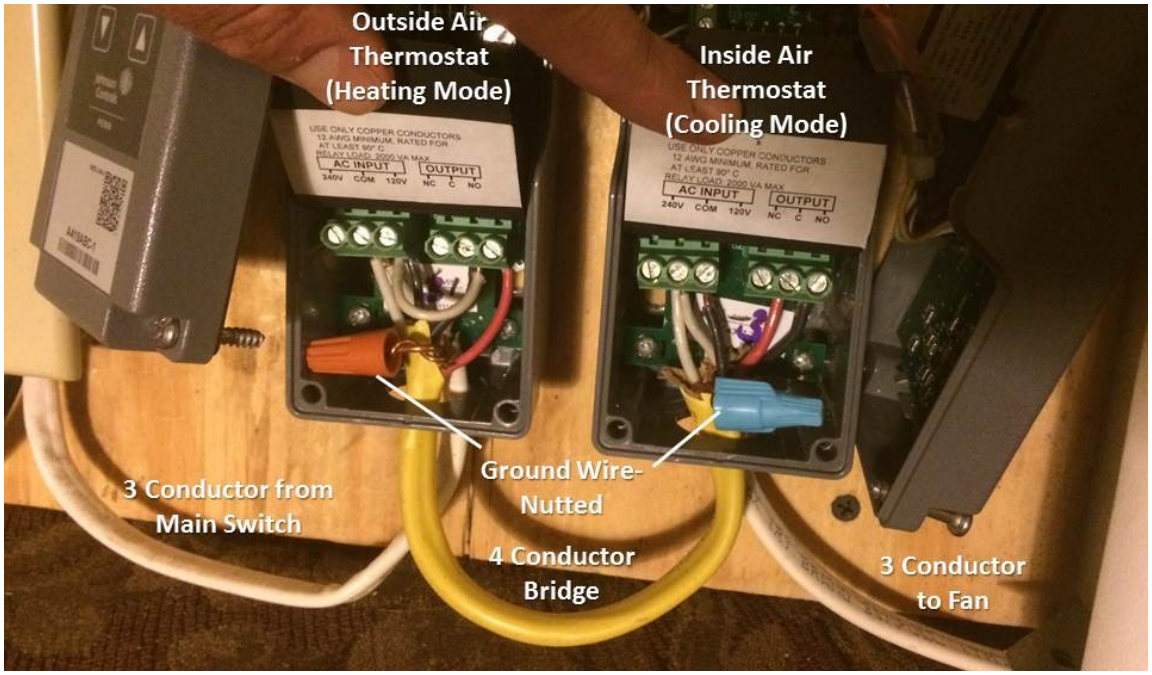
Electrical Schematic & Wiring

This system is designed to run on single phase 120 VAC. The electrical schematic is provided to the right and a picture of the actual wiring is provided below. One important feature is that 120 VAC is wired directly to both thermostats to allow for operation and power of the display even when the first thermostat is not "pulled in."





This shows the actual wiring of the thermostats (Johnson Control A419's in this case.) Note the use of 4 conductor wire between the two thermostats to allow both full-time power to the second thermostat's display and switched power to the controlled terminals.

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