

HVAC Mote Documentation

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1 Description

The HVAC (Heating Ventilation and Air Conditioning) mote serves three primary purposes: relay control, temperature sensing, and power price indication as per the Demand Response framework. Circuitry also exists for quick hardware installation of an optional UI board (found in the AC receptacle mote), which adds an LCD screen for temperature and other user information displays.

1.1 Relay control

Residential HVAC at the thermostat level works by shorting the 24VAC line to the heat (heating), compressor (cooling), or fan line, usually in response to some predetermined change in temperature. The HVAC mote implements this functionality with three relays tied to the 24VAC and respective heat, compressor, and fan lines. When the telos mote receives a relay command from the controller, it sets its expansion pins (see Table 1) to turn the corresponding relay on or off .

Since the relays are latched, power is saved by only setting/resetting the relay for the amount of time necessary to switch - about 5 ms. Unlatched relays, in comparison, must be continuously powered in the ON state.

1.2 Price indication

Price indication occurs with four LEDs and their respective colors: blue (peak), red (high), yellow (medium), green (low/normal). The LEDs are controlled by an I²C chip which operates off the I2C Clock and I2C data expansion pins on the telos. Refer to Table 2 for an LED pin mapping to the I²C pins. For low power consumption, the LEDs operate off 3mA in the default setup. If this is not sufficient, the 1K and 1.5K resistors tied to the LEDs can be switched to lower resistive values.

1.3 Temperature sensing

Temperature sensing is achieved by connecting a thermistor to the mono jack located next to the compression terminals. Because the thermistor is powered straight off the battery, there is no voltage regulation. This means that when calibrating the thermistor, the current battery level must be accounted for and used to find the correct calibration curve.

012	Relay command
000	Compressor ON
001	Compressor OFF
010	Fan ON
011	Fan OFF
100	Heat ON
101	Heat OFF

Table 1: Relay commands - in this case, 0 refers to ADC0, 1 to ADC1, and 2 to ADC2.

I ² C pin	LED Color
4 (I/O 0)	Blue
5 (I/O 1)	Red
6 (I/O 2)	Yellow
7 (I/O 3)	Green

Table 2: I²C pin mapping

On the telos, the thermistor voltage is read off the ADC3 expansion pin.

1.4 User interface board

Pins for JTag and a 14 pin header have been added to the circuit board for future implementation of the AC receptacle mote UI board.

2 Installation

Installation is relatively simple. The HVAC mote is designed to be used in the four wire HVAC configuration commonplace to a large number of residential buildings. The four wires are colored red, white, green, and yellow, for the 24VAC return, heat, fan, and air compressor respectively. To install the HVAC mote, simply connect the wires coming out of the wall (or previously connected to the thermostat) to the color-coded compression terminals on the side of the HVAC mote.

Now, connect the thermistor to the mono jack located on the same side as the compression terminals.

Finally, make sure the on/off switch is in the on position. Installation complete.

3 Notes

3.1 General

In the event of hardware or battery failure, the HVAC mote can be manually overridden by the switch located at the top of the unit. This breaks the connection between the 24VAC and the rest of the circuit, effectively switching off any relay that might be set ON.

3.2 Programming

Pin mappings have been outlined in previous sections. For efficient power consumption, the HVAC mote should be programmed to turn the radio on at 10 or 30 second intervals. This assumes that the controller will then send any price/relay change commands for at least 10 or 30 seconds (respectively). Also, relays should be set/reset for the minimum time necessary to switch (about 5 ms). The relays draw about 55mA when powered, so savings here can be very significant.

3.3 Eagle

In the Eagle board file, layer 100 (yellow wire) denotes the jumper wires. Since the HVAC mote was created on a single-sided PCB, these wires must be manually soldered in. Also, the fingerprint for the transistors in the board file and the physical transistors differ, so the transistors must be positioned opposite to how they appear in the board file.