

2. Design Constraints

The purpose of this project is to create a portable and PC-based thermostat. The remote can be taken to a room and the HVAC will operate until the desired temperature is obtained at the remote. The HVAC system can also be operated from a PC that acts as a fully functional thermostat and as a base station for the remote. The design constraints for the Portable Thermostat project include the following five technical constraints and five real world constraints.

1. **Temperature Sensing:** The temperature sensor will measure temperatures from 50°F to 90°F. The user will be able to adjust the temperature between 55°F and 85°F.
2. **Computer Connectivity:** The EIA RS232E standard will be used to connect the base hardware unit with the PC.
3. **HVAC Connectivity:** The base hardware unit will connect to standard 5-wire HVAC systems. Some 5-wire systems contain a sixth wire, which is a common. HVAC units that have the extra common wire will operate with this thermostat. This thermostat is not compatible with heat pump systems.
4. **Anticipator:** The anticipator will allow the user to adjust cutoff temperature by minus 3°F when mode is set to heat and plus 3°F when mode is set to AC.
5. **AC over Current Protection:** The base will contain a trip time to keep the HVAC system from cycling on and off too quickly. This can cause undue stress to the HVAC unit and excessively high currents to the compressor.
6. **LCD output:** The remote unit will display the ambient temperature, desired temperature, and mode of operation (Heat, AC, Off) on a character LCD that contains 1 line and 8 characters.
7. **Cost:** The target price is \$200 manufactured. This does not include the RF module used in the prototype. The RF cost will be determined by estimated costs of similarly sized transmitters as if one were specially made for this application.
8. **Operating Systems:** The PC software will be compatible with Windows 95, Windows 98, Windows ME and Windows XP operating systems.
9. **Remote Weight:** The remote's weight will be no more than 10 ounces.
10. **Base Unit Mounting:** The base unit will be wall-mountable with the option of connecting the RS232 and power cable to the back or bottom of the unit. The HVAC wires must be connected through the back.

2.1. Temperature Sensing

The temperature sensor will measure temperatures from 50°F to 90°F. The user will have the ability to adjust the temperature between 55°F and 85°F. According to guidelines published by the California Department of Energy, the lowest recommended temperature is 55°F [1] during winter nights or when no one is home for long periods of time. The

highest recommended temperature is 85°F during the summer. Many factors such as humidity and airflow affect the desired temperature of a room. The human comfort zone is between 69.8°F and 75.2°F [2]. By choosing 55°F to 85°F the full range of temperatures can be taken into account.

Heating and cooling systems have a tendency to “overshoot” the desired temperature. To correct this, an anticipator is used to turn off the HVAC system before the desired temperature is reached. The anticipator value is normally set during installation. For example, suppose the user sets the thermostat to “Heat” and the temperature to “70°F”. If the anticipator is set to -1°F for the heating system, the system will operate until the measured temperature is 69°F.

2.2. Connectivity

The PC will connect to the base hardware through EIA standard RS232E. This was chosen because most PC's have at least one RS232 interface [3]. The base hardware unit will connect to standard 5-wire HVAC systems. Some 5-wire systems contain a sixth wire, which is a common. HVAC units that have the extra common wire will operate with this thermostat. No formal standard has been found that specifies this [4]. This thermostat is not compatible with heat pump systems.

2.3. Anti-Short-Cycle Control (AC Over-current Protection)

When the air conditioning compressor turns off, the refrigerant is temporarily at a high pressure that slowly decreases over a period of a few minutes. If the unit is turned back on during this interval, the compressor has to perform a cold start against high backpressure, causing the compressor to draw very high current [5]. We will provide a delay where the refrigerant has time to depressurize before turning the unit back on. A delay of 1 minute will be used as commonly used in industry [4].

2.4. Physical Characteristics

The remote unit will weigh no more than 10oz to allow for easy mobility while carrying the remote. This designated weight was chosen because it is comparable to other handheld devices such as cell phones and graphing calculators.

The base unit will be wall-mountable. This will allow the HVAC wires to remain inside the wall eliminating the need for a wall jack and wire harness. The HVAC wires will connect to the unit through the wall side only. The user will have two options when connecting the RS232 and power supply to the unit. Connectors will be provided on the back and bottom of the unit. The connectors on the back of the unit will allow the user to install RS232 and power in the wall creating a “clean” look around the unit. If the user does not wish to install either or both wires in the wall, then the user can connect to the unit on the bottom.

2.5. Base Unit

The target price is \$200 after manufacturing. This is very competitive with similar units that list for \$219 and \$246. The price does not include the RF module. The RF module used in the prototype is not necessarily what would be used for production. If the thermostat were to go into production a custom RF module would be designed for this application. The RF cost will be determined by estimated costs of similarly sized transmitters as if one were specially made for this application. [6]

References

- [1] California Energy Commission, “Get comfortable you’re your setback thermostat”, http://www.energy.ca.gov/efficiency/home_energy_guide/SETBACK_THERMOSTATS.PDF
- [2] Verlag fur Architektur Artemis Zurich, *Ergonomics of the Home*. London. Taylor and Francis Ltd. 1973
- [3] J. Axelson, *Serial Port Complete*. Madison, WI: Lakeview Research, 2000.
- [4] Jamie Foster, Martin’s Heating and Cooling, Mendenhall, MS. Personal Interview, March 25, 2003.
- [5] E.F. Mahoney, *Reading and Interpreting Diagrams in Air Conditioning and Refrigeration*. Reston, VA. Reston Publishing Company, Inc. 1983.
- [6] Quin Jones, Maxstream Wireless Inc., Personal Interview, April 21, 2003.