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Functional Specification for a
Remotely Accessible Temperature Control System

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Executive Summary

Since its inception, the Internet has revolutionized the communications world and has provided a powerful means of transferring information. Access to the Internet is available now more than ever, so we at Holla Home Solutions envision its use to provide peace of mind and comfort, as well as decreased energy consumption in the home and office space.

Holla Home Solutions will develop a *Remotely Accessible Temperature Control System* as a first step in achieving our vision. The system allows the user access and control of their home's current heat settings as well as set a pre-programmed temperature schedule from any Internet connection. Unexpected changes in schedule or simple bouts of absent-mindedness can be conveniently managed while on the road or even out of the country. Still remaining is the ability to make changes to settings manually in the home.

As part of the first phase of development, the Holla team will construct the basis of a remotely accessible smart appliance control system. There will be a potential to integrate the control of multiple appliances remotely from a single user interface. Additional controllers for these devices will follow in later development phases. The system will work in conjunction with existing home heating systems and wireless Internet connections.

As proof of concept, a prototype of the remotely accessible temperature control module will be completed by the end of March, 2005.

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Glossary

ANSI	American National Standards Institute
HTTP	Hypertext Transfer Protocol
HVAC	Heating, Ventilation, & Air Conditioning [1]
IEEE 802.11b	Often called Wi-Fi - is backward compatible with 802.11. The modulation used in 802.11 has historically been phase-shift keying (PSK). The modulation method selected for 802.11b is known as complementary code keying (CCK), which allows higher data speeds and is less susceptible to multipath-propagation interference. [2]
W3C	World Wide Web Consortium [3]

1 Introduction

The Remotely Accessible Temperature Control System allows access and control to a users heating system from any Internet connection. This is the first phase in the development of a remotely accessible smart appliance control system, which would allow remote control to a network of integrated appliances. Working in conjunction with a home's existing heating system and wireless Internet connection, the temperature control module is scheduled for completion at the end of March, 2005.

1.1 Scope

This document describes the functional requirements of an operational Remotely Accessible Temperature Control System. Provided is the complete set of functional requirements for a proof of concept device including mandatory and ideal requirements. The requirements have been divided into overall system requirements, subcomponent requirements, and interface requirements. A test plan is also included to verify the performance and functionality of the proof of concept implementation.

1.2 Intended Audience

The functional specification is to be used by the design engineers as a reference during the design and implementation of the prototype. The Holla CEO will use this document to measure project performance and implementation objectives.

1.3 Notations

This document uses the following notations to differentiate between mandatory requirements that must be met as well as ideal requirements, which must be met in a production model but should be met on the prototype. This document also uses a separate notation for test requirements.

M[#] This notation indicates that the specification is a mandatory requirement.
I[#] This notation indicates that the specification is an ideal requirement.
T[#] This notation indicates the test requirement.

2 System Overview

This section is provided to illustrate the system's operation without specifying any functional requirements. Figure 1 shows our proposed solution for creating a remotely accessible temperature control system. The *thermostat* block represents the system that Holla Home Solutions will create, and that will be used in conjunction with the remaining blocks to control the temperature of a building. Specifically, the *thermostat* will control a furnace and will be able to communicate to a wireless network. The user will have access to the thermostat at both the device's physical location and remotely through the internet.

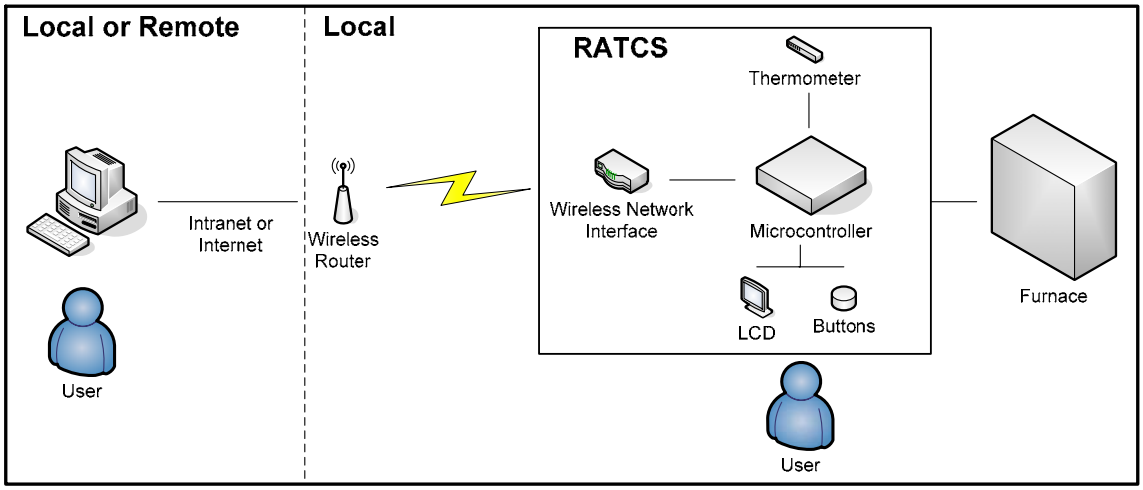

Figure 1: System Overview

3 System Requirements

This section states the requirements associated with the system as a whole. Detailed specifications will be provided in later sections.

3.1 General

This section defines the core functionality of the unit.

M[1] The unit must be able to control the temperature of an HVAC standard home gas furnace.[1]

M[2] The unit must allow the user to read and set the current temperature.

M[3] The unit must provide a user interface both on the device and remotely. The remote interface must be available via any web browser, include Microsoft Internet Explorer and Mozilla FireFox.

M[4] The unit must provide temperature schedule programmability such that the user can preset the temperature for a rollover of seven day periods at 3 hour intervals or less.

3.2 Performance

The performance between the thermostat and all external connections is defined here.

M[5] The unit must provide real-time operation, such that the unit provides a response to user requests within one second of receiving a user request.

M[6] The unit must not toggle the state of the furnace more than once every 1 minute during programmed operation.

3.3 Reliability

Being a home appliance, certain safety and reliability issues must be addressed by the unit.

M[7] The unit must be able to operate without fail continuously for a minimum of seven days.

M[8] The unit must never adversely affect the furnace it is controlling.

3.4 Physical

Physical characteristics of home appliances are addressed here.

M[9] The unit must mimic the physical dimensions of a conventional digital thermostat, fitting into a box no bigger than 45cm x 45cm x 6cm.

M[10] The power consumption of the unit must be such that the external temperature of the unit never exceeds 30^{o}C.

M[11] The unit must operate correctly between 0^{o}C and 40^{o}C.

4 Standards Compliance

The unit is designed for home use, and relies on existing technologies for full operation.

M[12] The unit must communicate to a home network using the ANSI/IEEE Std 802.11b Wireless Local Area Network Medium Access Control and Physical Layer specification. [2]

M[13] The unit must expose its remote interface through the W3C Hypertext Transfer Protocol (HTTP).

5 Subcomponents

This section contains the functional specifications and requirements of the individual components that comprise the overall system.

5.1 Controller

M[14] The unit must be able send, receive, decode and acknowledge wireless communication from a client using the 802.11b standard.

M[15] The unit must be able to power and receive/decode button commands from an external button panel.

M[16] The unit must be able to power, control and operate an LCD screen.

M[17] The unit must be able to operate constantly, without the need for shutdown or restart.

M[18] The unit must be able to be controlled both remotely and locally.

M[19] The unit must be able send the needed supply voltage to operate a thermometer.

M[20] The unit must be able to integrate and decode a temperature reading from a thermometer.

I[1] The microcontroller should be able to connect to the client via Ethernet connection.

5.2 Thermometer

M[21] The thermometer must be able to be powered from the micro-controller board.

M[22] This unit must have a range of temperature readings between $0-40°C$, with a resolution of $1°C$.

5.3 LCD

M[23] The LCD should be able to be powered and operated via the micro-controller.

M[24] The unit should have at least a 2x16 character display screen space.

M[25] The unit should be able to display the system's current status and a menu.

5.4 Buttons

M[26] There must be at least 4 external buttons.

M[27] Each button must be at least 10x10mm's to provide the user with a comfortable pressing surface area.

M[28] The buttons must be able to be mounted to a surface no larger then 14x5cm's.

6 Interface

The user interface consists of physical control mechanisms locally on the device as well as remote control mechanisms; requirements for the interface will be defined in terms of these two aspects.

M[29] Both the local and remote interface methods must have two modes of operation, one for setting the current temperature (normal mode) and one for temperature schedule programmability (programming mode).

6.1 Local

The local interface will consist of an LCD and buttons that are physically attached to the controller, which replaces an existing thermostat.

M[30] Two of the buttons must be dedicated to setting the temperature up and down in both modes of operation.

M[31] Two of the buttons must be dedicated to maneuvering through the temperature scheduling options.

M[32] The LCD must always show the current and current set temperature when in normal mode.

M[33] The LCD must show the temperature schedule programming interface when in programming mode.

6.2 Remote

M[34] The remote interface must be accessible over the internet.

M[35] The remote interface must provide a graphical user interface.

M[36] The remote interface must display the current and current set temperature.

M[37] The remote interface must allow the current temperature to be set.

M[38] The remote interface must allow temperature schedule programming.

7 Test Plan

This section outlines the plan by which testing of the functionality of the Remotely Accessible Temperature Control system will take place. The functional specifications thus far outlined in this document will provide an essential guideline in testing the device. Testing will involve component testing, software integration testing, and complete system testing.

Component testing will involve testing of the individual components in terms of hardware as well as testing the corresponding software modules to prove functionality. Software integration testing will involve testing each component with the controller as well as testing remote accessibility. System testing will involve proving the functionality of each requirement outlines in the system requirements portion of this document. The following test requirements outline the testing strategy where functionality refers to described functional requirements.

T[1] Test components and corresponding software modules for correct functionality.

T[2] Test components together with controller for correct functionality.

T[3] Test remote accessibility of controller together with components.

T[4] Test complete system connected to furnace for functionality.

T[5] Test system extensively for long term reliability.

8 Documentation and User Training

The Remotely Accessible Temperature Control System is intended to be installed in homes. However, the task of installation will likely be beyond the capabilities of the average user, hence installation will be completed by a certified electrician made available upon purchase of the device. The documentation that will be produced according to the following specifications will aid users with less than average technical ability to use the Remotely Accessible Temperature Control System to its fullest extent.

M[39] A short user manual will be provided in English with further languages provided as the popularity of the device grows.

M[40] Copyright and warranty information will be provided.

M[41] A FAQ page will be provided, providing answers to common questions that home owners may have.

M[42] A company website will be provided containing contact information and device specifications.

I[2] A detailed user manual will be provided for those who wish to install the device on their own and wish to take greater control of their device.

9 Conclusion

This document sets rigorous functional requirements for Holla Home Solutions' Remotely Accessible Temperature Control System. The system's core functionality, performance, reliability, and physical requirements have been outlined as well as the necessary compliance to applicable industry standards. Test plans and documentation specifications are also provided in this document. This list of detailed product specifications will provide the Holla team with the guidance to design and produce a system of the highest quality and usability.

References

[1] American Society of Heating, Refrigerating, and Air-Conditioning Engineers
http://www.ashrae.org

[2] Institute of Electrical and Electronics Engineers
http://www.ieee.com

[3] World Wide Web Consortium
http://www.w3c.org