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March 5th, 2009

Mr. Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
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Re: ENSC 440/305 Project Design Specification for Smart Stove

Dear Mr. Leung,

The attached document, *Smart Stove Design Specifications*, outlines the design specification for our project for ENSC 305/440. Smart Stove is an innovative pixilated induction cook top that allows the users to put the cookware anywhere on the surface. The design specification will outline the design requirements that Smart Stove prototype will adapt in order to meet the functional requirements as outlined in the functional specification.

Our design specification describes the design considerations that our system will takes into account. It consists of a system overview, as well as the input, control, power, output, casing module.

Thermopix Inc. is comprised of four creative, motivated and experienced engineering students: Phoebe Liu, Claire Wu, Hao Su and Andrew Lin. If you have any questions or concerns regarding our design specification, please feel free to contact me by phone at (604) 436-5755 or by e-mail at pliu1@sfu.ca.

Sincerely,

Phoebe Liu
Chief Executive officer
Thermopix Inc.

Enclosure: Design Specifications for Smart Stove

Smart Stove Design Specification

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Table of Contents

List of Figures

List of Tables

1. Abstract

The heating technology of the Smart Stove is based on the method of induction cooking. Induction cooking has already long been widely accepted around the world, both in a professional and personal realm. In recent years, induction technology has improved exponentially, while development and production cost has reduced dramatically. Smart Stove makes many new and exciting high-tech improvements to the traditional induction cooker, adding the ability for the user to place the pot anywhere on the smooth cook top with our arrays of pixilated heating elements, and cook with as many pots and pans that will fit simultaneously. The induction sensors on the Smart Stove also sense how many pots are being used and the location and size of each pot on the stove. The user-friendly GUI then graphically maps these pots and allows the user to adjust the temperature and timer of each pot individually, thus completely automating your cooking experience.

The development of the Smart Stove will occur in several iterations. Thermopix Inc. has made the decision to outsource the control circuit for our system, due to the power constraints imposed by the electronic components and the power supplies. This will minimize the design decisions, thus minimizing the susceptibilities from external factors. This does not imply that the development of the Smart Stove will be limited to the control circuit, rather design decisions will be made to improve Smart Stove. The control circuit will be implemented with features as outlined in the functional specifications, such as:

- Resistance to high voltage and current susceptibility
- Automatic detection of cookware placed on the surface
- Integration of individual heating elements to achieve the pixilated structure of the cook top

The second iteration of the development will focus on the software algorithms that will automatic categorize each pot as an individual component, as well as controlling the specified pot. Designs decisions will also be made to ensure that Smart Stove fulfill the safety and environment standards. Other design considerations will focus on the casing and mechanical calibration of the cook top to ensure that the system is capable of withstanding the specified weight and pressure.

The design specification document the design details that Thermopix Inc. will be adapt. The completion of this proof of concept will be completed by April, 2009. A test plan will also be included in the design specifications that show testing will occur in parallel. Analyzing and interpreting the significance of the data results will prove to be a key component to the success of the first iteration of the prototype.

2. Introduction

Smart Stove is an innovative home appliance that provides users convenience while being energy efficient, safe, and easy to clean and maintain at the same time. With the large surface area of available heating elements, it is easy to achieve the desired efficiency in time and energy by allowing more cookware to be heated at the same time, as compared to that of conventional cook top. Since induction heating mechanism can only work with magnetized cookware, the system results in dramatic energy savings than traditional electric or gas cook-tops. Without constraints of fixed heating area, users will be able to heat up any size of cookware anywhere within the surface area. After the sensors detected a pot is placed on the surface, LEDs will flash to indicate where temperature adjustments are applicable. The project is divided into two increments. Increment 1 will be completed during ENSC 440 and will mainly focus on electrical prototype of 3 by 3 heating elements. Increment 2 will add further features and improvements, mostly focusing on LCD touch screen control.

2.1 Background

In present days, most households are still using traditional gas or electrical stoves, which concerns for energy waste and safety need to be taken into account [1]. Conventional induction cook top will achieve energy conservation and safety. However, all the current commercial stoves encounter numerous constraints due to its fixed heating area and limited heating elements per unit cook top. With Thermopix Smart Stove, many problems discussed above can be solved.

2.2 Scope

This document presents the details of design specifications for Smart Stove. The following design specification ranges from the power generation module, input conversion module, control and processing module, output conversion module, to casing and mechanical module. Also, the general test plan is included and which verifies and ensures all the functionalities and requirements mentioned in the design specification will be satisfied.

2.3 Intended Audience

The primary intended audience for this document is the project managers, research and development engineers, and quality assurance personnel. These design specifications will act as an outline of Smart Stove's design solutions from research and development team. The managers are obligated to use this document to monitor project progress and to determine the project direction. By the end of the product cycle, this document will also provide business groups for further references.

3. System Overview

Smart-stove provides great improvement over the existing design solutions of induction stoves. It provides ease of use by simply placing the multiple cookwares anywhere on the cook-top surface, thus allowing the user to heat up more cookware than with similar sized conventional induction stoves.

Figure 3-1 shows the architecture overview comprised of the various modules of the Smart-stove's design. The Input Conversion Module includes the temperature adjustment buttons, temperature sensors, and the cookware detection hardware and algorithms. The Power Generation Module includes the power circuits that generate a resonance waveform for the induction coils, and the DC circuit that powers the input, control and output modules of the system. The safety module is together with the Power Generation Module because the power circuit with high voltage and current is the most dangerous to the user. The safety module includes the insulating case that covers the power circuitry, as well as heat sinks to prevent overheating, and fuses and regulators to prevent abnormally large currents and voltages. The Output Conversion module displays information about the status of the system to the user. This includes the induction coil LED display and the temperature control LED display. Finally, the Control and processing module consists of the microcontroller and other logic circuits that controls and regulates the operation of the Smart-Stove.

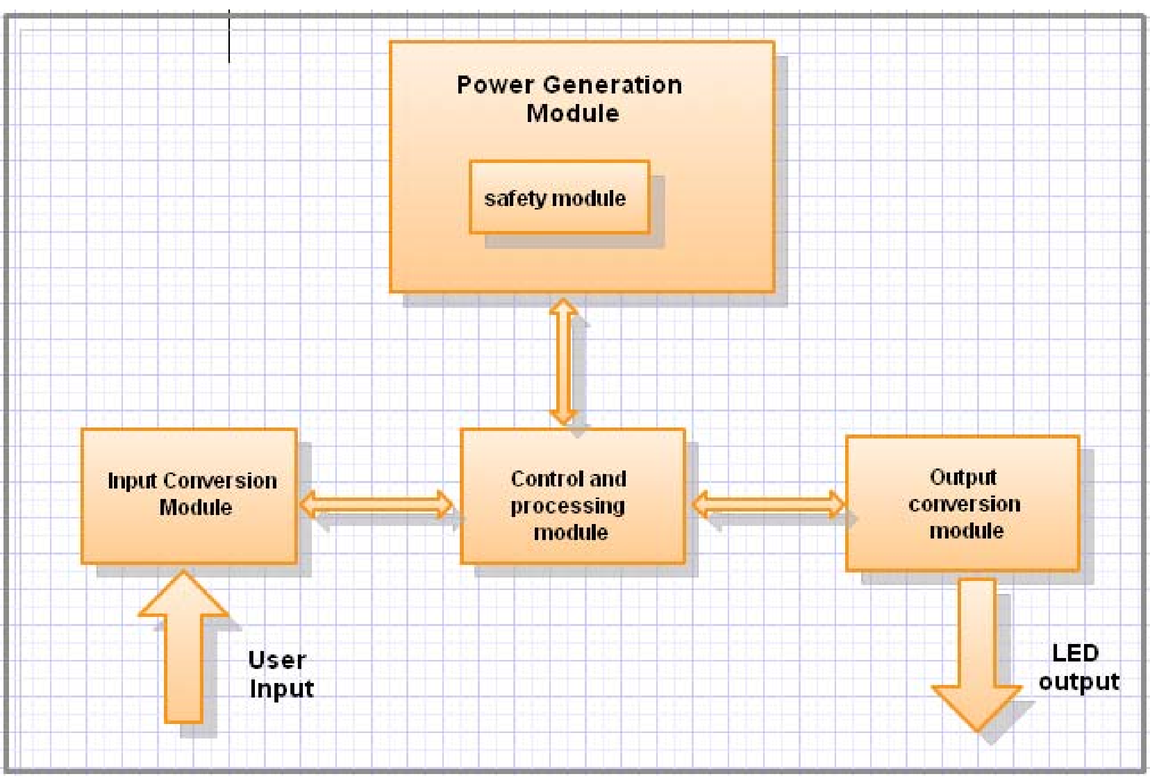

Figure 3-1 Smart-stove system architecture overview

4. Power Generation Module

The power generation module provides the induction heating applied to the system. In layman term, the power source used in our system will be from the AC power supply, which is then converted to DC using a rectifier. The DC current is connected to a high frequency switching circuit to administer high frequency current to the heating coil, which then creates a high frequency magnetic field around the heated induction coil. Generally speaking, induction cook top employs two types of topology used in the power system: a half-bridge series resonant converter and a quasi-resonant converter. Smart Stove will employ the quasi-resonant converter because it only needs one switching circuit inside, which makes our system less complicated with reduced heat sinks and PCB size.

4.1 Main Power Circuit

Figure 4-1 below shows the system block, consisting of a main power circuit, input current detection circuit, control circuit, and SMPS circuit. The block diagram of a quasi-resonant converter is shown in a streamlined form. The SMPS will supply 18V, to the DC cooling fan and the control circuit. 5V of the 18V generated by the SMPS will be supplied to the comparator LM339 for various testing data, then to the MICOM to execute instructions. The SMPS we will be using is the VIPer12 low power offline primary switch, and will using be used as a voltage regulator circuit. The VIPer12 is employed because of its wide voltage range, voltage regulator characteristics, and more stable than discrete components.

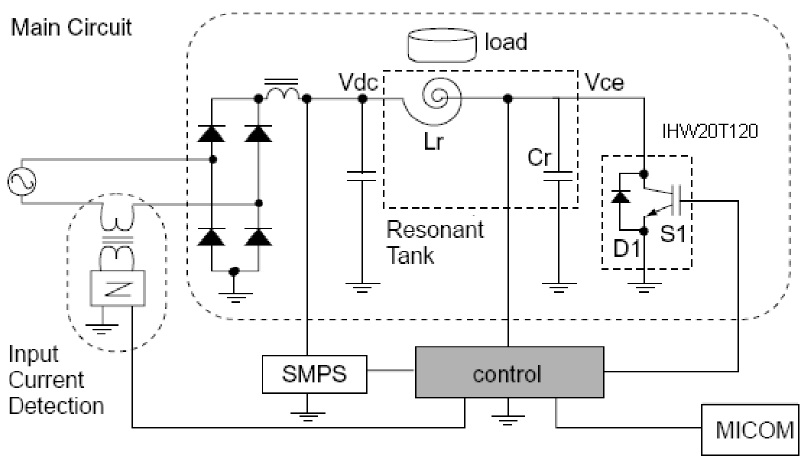

Figure 4-1 Power System using a Quasi-resonant Converter

As shown in the diagram above, the main power circuit consists of the IGBT (Insulated Gate Bipolar Transistor, IHW20T120) and a diode connected in parallel. The pin assignments for the IGBT are shown in Figure 4-2.

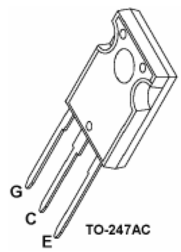

Figure 4-2 IGBTIHW20T120 (Infenion Technologies, 2004)

By turning on the IGBT while the diode is in turn-on state, it is possible to do a turn-on switching with the voltage and current remaining at zero. When D1, connected to S1 switching circuit, is in turn-on state, zero voltage turn-on switching is available as V_{CE} of the circuit becomes zero. In this circuit, the switch must endure high internal pressure to accommodate the high voltage of V_{CE} administered to both ends of the switch. Figure 4-3 shows the waveforms of each block of the main power circuit in a cycle.

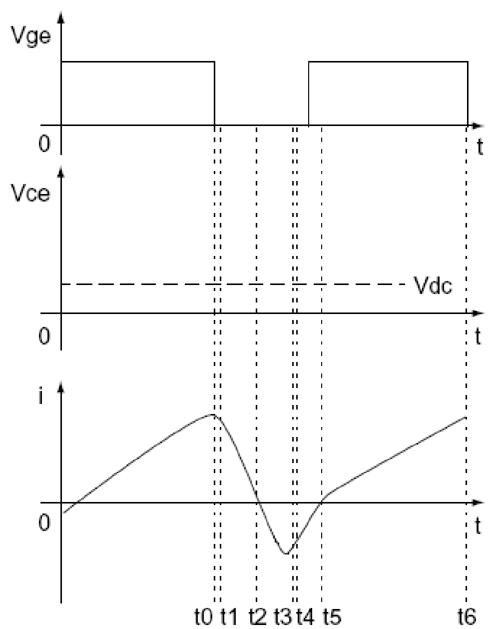

Figure 4-3 Waveform of the Main Power Circuit

The resonant circuit is composed of resonant inductance (Lr) and resonant capacitance (Cr).

4.2 Safety Module

To prevent over voltage and over current for system protection, additional protection circuits need to be used. When the induction cooker is running, it may generate an over voltage when the IGBT is turning on and off repeatedly, thus damaging the IGBT. A potentiometer ‘0V’ is connected to the Analog-to-Digital converter input, and the microcontroller detects this voltage to control and regulate the output power.

When current is flowing through the IGBT higher than expected, it may also damage the IGBT. A current transformer can be used between the power line and the rectifier. A voltage can be detected, and then transferred from the current transformer to control and regulate the output power and protect the circuit. The over current will be compared with the standard current through a comparator.

As of this point, we have not determined which isolation circuit we will be adapting. Two methods are being debated now: pulse transformers and gate driver optocouplers. The pulse transformer is a traditional and simple solution, but will increase the circuit board size and parasitic inductances, in turn, increases power. The gate driver optocoupler IC integrates an LED light source and optical receiver for safety isolation, with transistors to provide sufficient drive current.

4.3 Functional Specification List

The functional specifications of the power generation module are listed in Table 4-1.

Table 4-1 Functional Specification List for System

Functional Specifications	Expected Value	Required Value (from Functional Specs)	Met?
Supply voltage	110V/220V	110V with ±10% fluctuation	Yes
Control knob power	<1W	<1W	Yes
LCD power	NA	<20W	
Current Drain at non-active mode	<35mA	<20mA	No
Protection Circuit	Included	Included	Yes

5. Input Conversion Module

The input conversion module consists of temperature sensing, pot sensing, and temperature adjustment sub-modules, in which each external signal will be converted into voltage level for further control uses. Through the control module, input readings of each sub-module will be ultimately determined from voltage level.

5.1 Temperature sensing module

The temperature input signals are generated by temperature sensors whose outputs are fed to comparators with a reference voltage. With a supplied reference voltage, temperature input signals are applied to positive terminal for comparison. We note that the temperature input signal is normally lower than the reference voltage. Therefore, the output of comparator is high as long as the reference voltage is greater than the applied voltage in this specific design. On the other hand, ground potential output will be generated if the input voltage is higher than the supplied reference level. Temperature interrupt sequence will be triggered once a low output signal is applied from a comparator. The following diagram shows the circuitry of input temperature sensing.

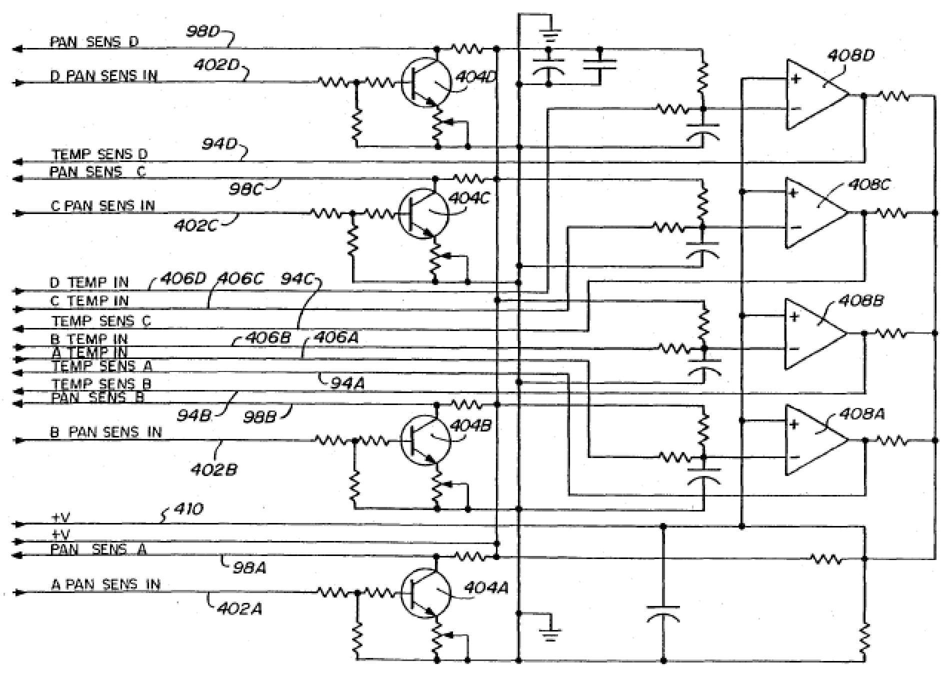

Figure 5-1 Temperature input circuit design

The output signal of comparator is inverted and level shifted by inverters and is applied to microcontroller for further control operations. From the above temperature input circuit design diagram, the remaining resistors and capacitors are designed to provide biasing and decoupling for transistors and comparators.

5.1.1 Selected Temperature Sensors

DO-35 Standard Glass Encapsulated Thermistor is selected as a temperature sensor in Smart Stove's input conversion design. The chosen temperature sensor has the following features: high temperature capability, high stability, high voltage insulation, and low cost from which Smart Stove will be able to meet all the requirements of temperature sensing mechanism in functional specification. Figure 5-2 shows the physical dimension of a DO-35 package.

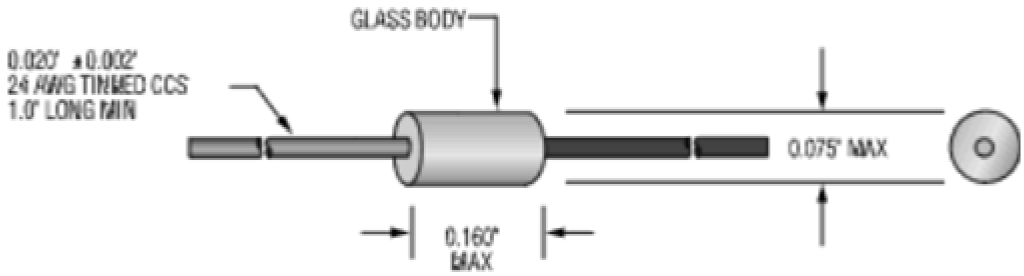

Figure 5-2 Glass encapsulated thermistor

The rated electric power (REP) of this thermistor is 2mW which is within our desired temperature sensing power rating, 50mW. Also, the sensing range, -25 Celsius to 300, is well covered Smart Stove's operating temperature.

5.2.2 Cost Analysis

DO-35 Standard Glass Encapsulated Thermistor is generally low cost, and the retail price for each thermistor is $0.969 CAD. Purchasing with larger quantity will lower down the cost to approximately 70% of its retail price. However, 3 by 3 prototype only requires nine thermistors; therefore the expected cost for temperature sensing is around $9 CAD.

5.2 Pot sensing module

In current pan sensing technology, the two most popular sensing methods are current pan detection and pulse pan detection. The pulse pan detection method is selected in Smart Stove design due to the following advantages: low power consumption, stable detection distance, and high resolution. Figure 5-3 shows the details of pan detection design circuit.

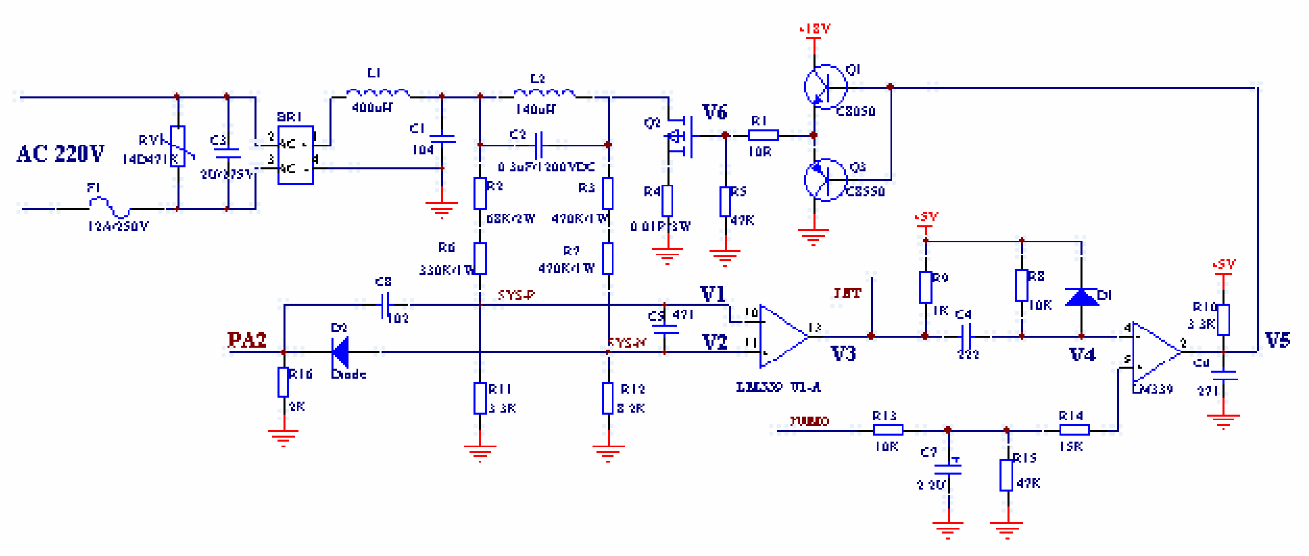

Figure 5-3 Pan Detection circuit

Pulse sensing method can be achieved by determining the status of IGBT and pulse counts. In such design, the IGBT will be off if there's no load on the surface of the stove. A high signal will allow the IGBT to operate at a fixed period of time, at which time the system will start counting pulses. By comparing the total counting pulses and the setup standard pulses, the system will be able to conclude if the pan allocates on the surface for detection purposes. Also, copper coil and resonant capacitor form oscillator, and its oscillation period is about 40us. The pan detection pulse timing diagram is shown as Figure 5-4.

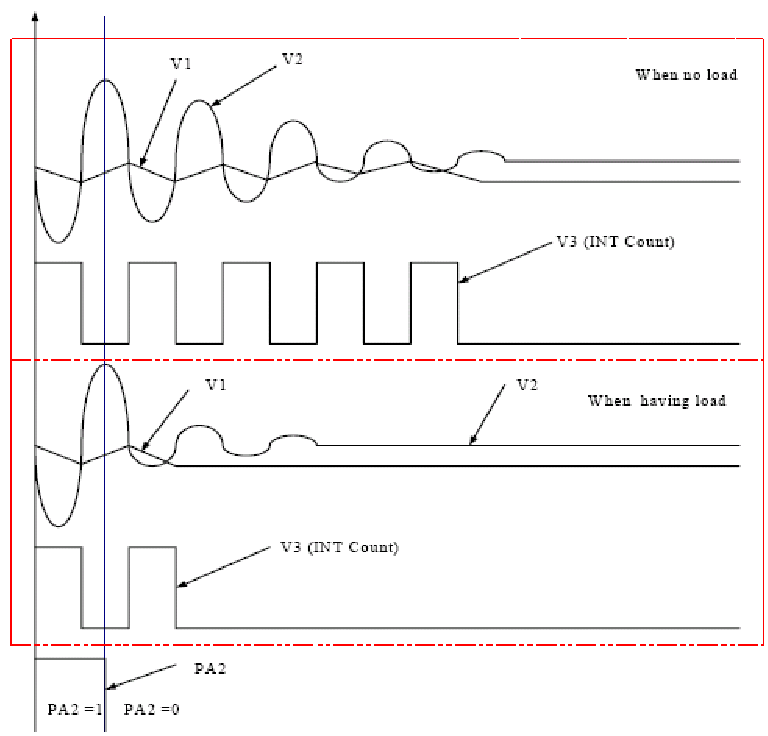

Figure 5-4 Pan Detection pulse timing waveform

Pan sensing mechanism will refresh every 2 seconds, so any removed cookware will be detected within the 2 seconds detecting cycle. In this design, to sense and control more than one cookware, users are required to position each pot with at least 2 seconds interval. Heating process will then be triggered once the cookware is detected, and the heating mechanism will be terminated if no pan/cookware is detected for continuously 20 seconds (10 times of pot sensing cycle).

5.3 Temperature adjustment module

In the Smart Stove's temperature adjustment module, users are able to select from three different temperature levels, 350F, 300F and 250F degrees Fahrenheit, for each heating cookware. The control panel design is shown in Figure 5-5.

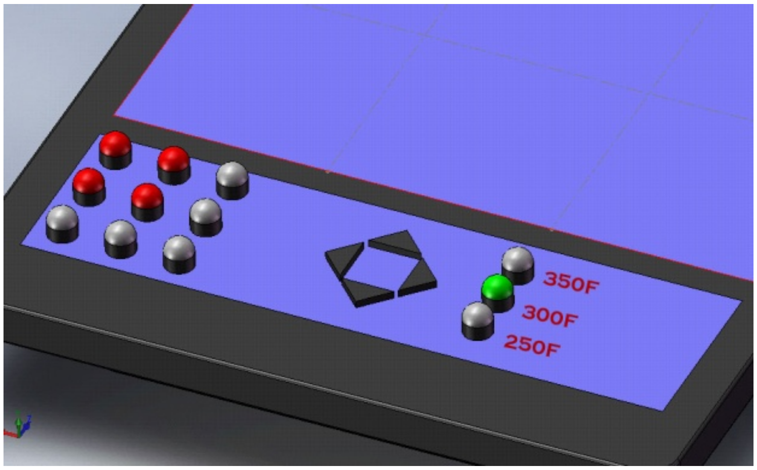

Figure 5-5 Control panel of Smart Stove

From Figure 5-5, the square 3 by 3 LED lights represent each heating element on the cook-top surface for indicating pan detection. With left and right control buttons, LEDs flash corresponding to the position of each cookware, and users will then be able to adjust heating level with up and down control buttons.

It is worth noting that LED control panel will be our phase one prototype due to time constrain; however, LCD touch screen control panel can be included for further market product manufacturing.

6. Control and Processing Module

6.1 General Processing Algorithm

Figure 6-1 shows the Control algorithm of Smart-Stove. After the user places a cookware on the stovetop, the inductive heating elements below will sense the change in inductance and get powered on, thus the induction heating begins. Initially, after the cookware has been detected, the system sets the goal temperature to a default value to ensure that the heating begins immediately. The user is then prompted to enter a new desired temperature as the goal temperature using one of the temperatures setting buttons. Each inductive coil heating element is fitted with a temperature sensor, and the detected temperature of the cookware is the average of all temperatures sensed by the coils below the cookware. Once goal temperature is exceeded by 5 degrees, the induction coils under the cookware will be powered off, while the temperature sensors keep detecting the temperature of the cookware. When the temperature of the cookware dips below the goal temperature again, the elements below the cookware will turn on again to resume heating. Heating will stop permanently when the user removes the cookware or power off the system.

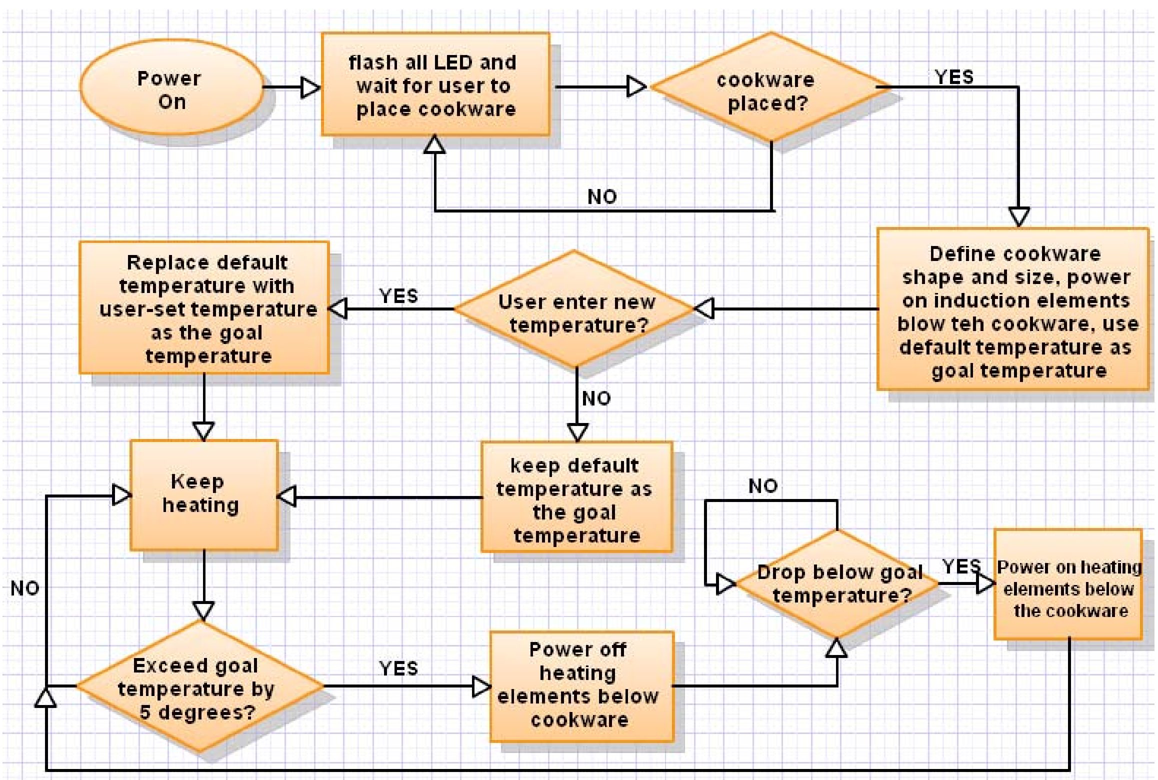

Figure 6-1 Control algorithm of Smart-Stove

6.2 SYSTEM COMPONENTS

The overall system implementation is shown in Figure 6-2. All processing will be done within the PIC 18F4520 microprocessor. Due to the nature of the Smart-Stove system, many input and output pins are required. There will be 16 input signals from the temperature sensor, 16 input signals from the coil detection sensors, up to 5 control button interrupt inputs, 16 induction coil power switch output signals, and LED array power switch signals. Note that we designed all signals to be 16 bits in case we have the extra time to implement a 4x4 heating element array. For the first iteration of the prototype implementation, we will use only 9 of the 16 bits to implement a 3x3 heating element array. In figure?, the unused pins of the PIC microprocessor will be used to implement the pushbutton interrupt inputs and to implement any additional devices we might need in future designs. To deal with the many input and output signals that must be processed by the PIC microprocessor, we have implemented 16-1 multiplexers for the inputs and 16 bit serial shift registers for the outputs. These multiplexers and shift registers will be explained in greater detail.

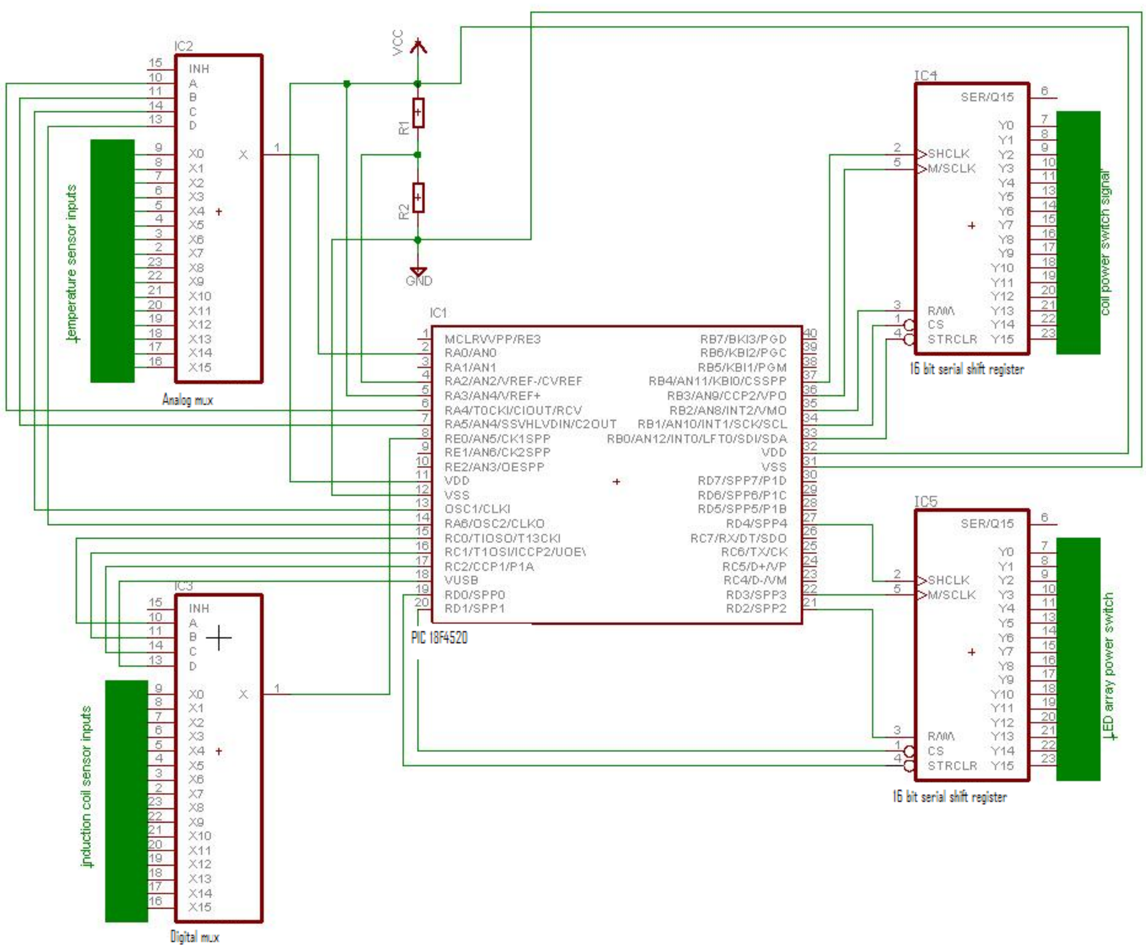

Figure 6-2 overall system implementation

6.3 PIC 18F4520 Microcontroller

The microprocessor we have chosen to use the PIC 18F4520 with 40 pins. This microprocessor has 13 general purpose I/O pins (can be used as both digital and analog) and 21 digital I/O pins. We are using 3 pins as analog input pins for the temperature sensor signals, and the rest as digital I/O pins. We are also making use of the microprocessor's digital-to-analog converter to process the temperature signals.

6.4 Analog multiplexer

To save pin usage at the microprocessor, our design includes an analog multiplexer to pick through each of the 16 temperature sensor signals. The signals arrive one at a time at the microprocessor, which converts it to a digital signal using the A/D conversion module, and saves it in memory. The analog temperature signal is generated using a resistive temperature sensor, which shows a different resistance at different temperatures. This sensor is put into a voltage divider configuration, and the voltage is fed to the analog multiplexer. The use of these analog multiplexers cuts down pin usage from 16 to 7 in the microprocessor. Referring to the schematic in Figure 6-2, pin 2 of the microprocessor is used as the input signal from the multiplexer, pins 4-5 are used as reference voltages for the A/D converter, pins 6-7 and pins 13-14 are used as the four multiplexer selection control bits.

6.5 Digital multiplexer

We used a digital multiplexer to save pin usage for the 16 induction coil input signals. The implementation of this multiplexer is similar to the analog multiplexer, except that the two reference voltage pins are now no longer needed. The use of these digital multiplexers cuts down pin usage from 16 to 5 in the microprocessor. Referring to the schematic in Figure 6-2, pin 8 of the microprocessor is used as the input signal from the multiplexer, pins 15-18 are used as the four multiplexer selection control bits.

6.6 Serial Shift registers

Two 16 bit shift registers are used to drive the induction coil switches and the LED array switches. After the microprocessor processes the input signals, the output signals are saved in memory (16 signals for the coil switches and 16 signals for the LED switches), and shifted one at a time into the shift registers. The shift registers then shift these bits to the storage register (built inside the shift register) to drive the switches. The pin connections of both shift registers are shown in schematic of Figure 6-2. The SHCLK refers to the clock that shift each bit serially through the register, and M/SCLK refers to the clock that stores the shifted bits inside the storage register. In other words, for every 16 pulses of the SHCLK, the M/SCLK clocks once to retain the value. The implementation of each of these shift registers cut down the pin usage from 16 to 5 at the microprocessor.

6.7 Cost Analysis

The Cost figures of each component are shown in Table 6-1. The total cost for the control and processing module is therefore $14.48, which meets the design specification.

Table 6-1 Cost of the components for control and processing module

Circuit Element	Physical component	# required	Cost per
8-1 analog multiplexers	IC MUX/DEMUX 8CH ANALOG 16-DIP	2	**$0.84**
8-1 digital multiplexers	IC 8-TO-1 DATA SEL/MUX 16-DIP	2	**$0.64**
8 bit shift registers	IC 8-BIT SHIFT REGISTER 16-DIP $0.88	4	**$0.88**
microprocessor	PIC 18F4520	1	**$8.00**
Total			**$14.48**

6.8 Functional specification requirements

This design of the control and processing module meets the functional specification requirements, as shown in Table 6-2. Calculations for each entry in Table 6-2 are not shown.

Table 6-2 functional requirements for control and processing module

Functional Characteristics	Expected/calculated value from design	Functional requirements	Met?
Processing time	<0.5ms	<1ms	**yes**
Dimensions	10cm x 15cm	10cm x 20cm	**yes**
Operating voltage	5V	<12V	**yes**
Voltage fluctuation	±0.1V(from regulator) or ±2%	±10%	**yes**
Cost	**$14.48**	**<$20.00**	**yes**

7. Output Conversion Module

7.1 Pot Detection Visual Indicator

The output conversion module for the pot detection indicator is simply arrays of LEDs depending on the number of elements used in the cook-top. The LEDs selected for the final implementation is power-efficient of less than 40mW and the luminosity of the LEDs is 20cmd. In the first prototype, the pot detection visual Indicator will use nine through-hole red LEDs and have the dimension shown in Figure 7-1.

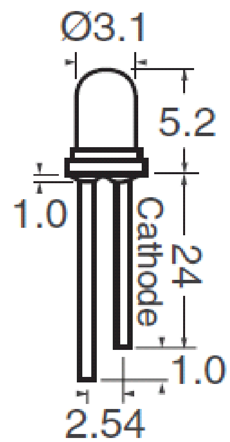

Figure 7-1 LED dimension

In combination with the input conversion module and the control and processing module, the output module should output a continuous red spectrum when a pot is detected on each element. This output is illustrated in Figure 7-2.

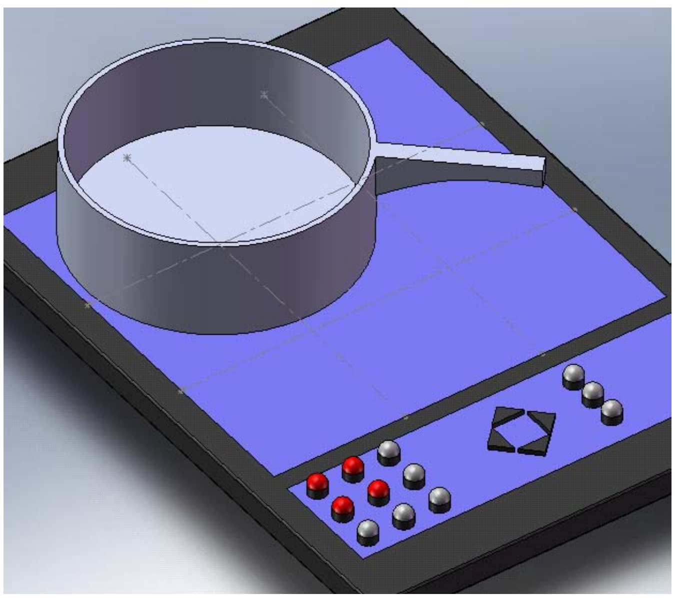

Figure 7-2 Pot Detection Visual Indicator module

7.2 Temperature Visual Indicator

For the temperature visual indicator, three simple LEDs are used to show three different temperatures at 300F, 250F and 200F degrees Fahrenheit. The same power rating and luminosity LEDs are used as the pot detection indicator shown in Figure 7-1. Using the left and right buttons, the user can select the desired elements to change the cooking temperature. The algorithm is further discussed in Control and Processing Module.

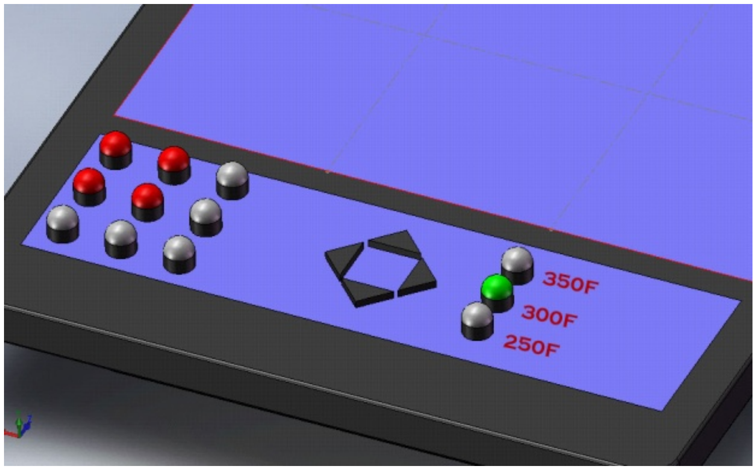

Figure 7-3 Temperature Visual Indicator

Once the desired pot is selected, the three green LEDs on the right of the device will light up according to the previous temperature set. Figure 7-3 shows four elements highlighted in red are at 300F Fahrenheit.

7.3 Cost Analysis

The cost of the output module is just the twelve LEDs used in the pot detection and temperature visual indicator. In general, LEDs are very low in price, available less than $0.10 CAD/unit in large quantities. The total price for the whole output module is roughly $1.20 CAD/unit.

7.4 Functional Specification List

The functional characteristics of the output module are listed in Table 7-1.

Table 7-1 Functional Specification of the LED

Functional Characteristics	Required Value
Size	3.1mm ø
Power	40mW
Color	Red (Pot Detection Indicator) Green (Temperature Indicator)
Response Time	Instantaneous
Operation Voltage	2V
Voltage Fluctuation	±10%

8. Casing Module

8.1 Design Overview

The mechanical design of the Smart Stove is intended to meet and exceed the guidelines outlined in the functional specification. By using the 3D design tool, SolidWorks, we created comprehensive models of each casing component. The detailed dimension of the casing components can be found in the Appendix.

8.2 Stovetop Surface

The stovetop surface is made of glass-ceramic material as it can sustain repeated and quick temperature changes. Moreover, it has a very low heat conduction coefficient as it does not transfer heat effectively. This is desired because there is no contact between the induction heating elements. As shown in Figure 8-1, the glass-ceramic area is highlighted in blue.

Figure 8-1 Final design of Smart-Stove

8.3 Casing and Cooling System

As the power modules generate heat, the bottom casing consists ventilation from the bottom, through the heat sinks mounted on the IGBTs and out from the side of the device. The fan used to cool the components has a 30CFM and 1.18W power rating. The characteristic of the fan used is shown in Table 8-1.

Table 8-1 Functional Specification of the fan

Functional Characteristic	Required Value
Manufacturer	Dynatron
Bearing Type	Ball Bearing
Size	120 x 120 x 25mm
Noise	20dBA @ 1m

RPM	900rpm
CFM	30 CFM
Power	1.2W

The cooling airflow for the device is shown in Figure 8-2.

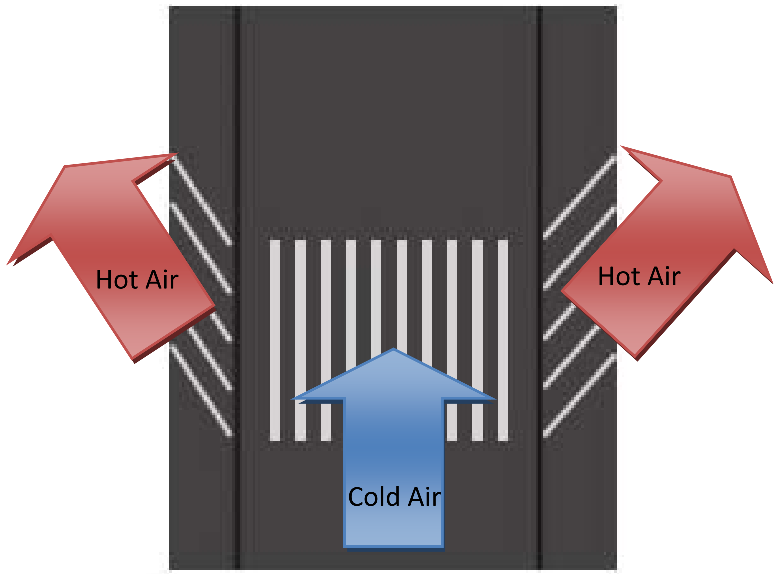

Figure 8-2 Cooling Airflow of the system

Moreover, the plastic used for the device has to be heat-resistant plastic as it should withstand any spills caused by the user.

8.4 Cost Analysis

In Table 8-2 , is a breakdown of the casing module per unit.

Table 8-2 Shows the breakdown of the casing module per unit.

Parts	Price in 1000 quantities
Glass-ceramic 6in x 6in	$20
Fan	$5
Heat-resistant plastic	$10
Total	$35

9. Overall System Cost

Based on the design we have chosen for each module, we estimated the total until cost of the Smart-Stove to be $80.20. Table 9-1 outlines every module cost per unit.

Table 9-1 Overall System Cost per module

Module	Volume Unit Cost
Power Generation and Input Conversion Module	$30 (Outsourced)
Control & Processing Module	$14
Output Module	$1.20
Casing and Cooling Module	$35
Total	$80.20

10. System Test Plan

The system Test plan outlined here is intended for testing the increment 1 prototypes of Smart-Stove. The intention of these tests is to meet the requirements outlined in the function specification. Table 10-1 summarized all the tests outlined in this section.

Table 10-1 Test Case Summary

Test Case #	Title	Module
T1	Basic Power testing	Power Conversion
T2	Tank Circuit	Power Conversion
T3	Multiple Coils	Power Conversion
T4	Basing Input Conversion	Input Conversion
T5	Multiple Coils	Input Conversion
T6	Microprocessor	Control and Processing
T7	LED testing	Output Conversion
T8	Basic induction heating functionality	System Function

10.1 Module Testing

10.1.1 Power Conversion Module Testing

Test Case	**T1 – Basic Power**
Description	This test determines if every component is supplied enough voltage and current. This will give us an idea of the power consumption of the device. The test involves operating DMM and Oscilloscope to make sure voltages are in an acceptable range.

Test Case	**T2 – Tank Circuits**
Description	This test determines if coils are working properly. The test involves testing the IGBTs are switching correctly and the circuit is in resonant to provide maximum efficiency.

Test Case	**T3 – Multiple Coils**
Description	This test determines if multiple coils are working properly. The test involves testing if power consumption is an issue.

10.1.2 Input Conversion Module Testing

Test Case	**T4 – Basic Input Conversion**
Description	This test determines if a single coil turns on or turns off if the system detects a pot placed on top of the ceramic. This is also a safety and energy conservation test as it will cut the power if no pot is placed.

Test Case	**T5 – Multiple Coils**
Description	This test determines if the array of coil functions and turns on accordingly when a pot is placed directly on top of the coil.

10.1.3 Control and Processing Module

Test Case	T6 – Microprocessor
Description	This test determines if software is coded give the results desired. The test involves testing the microprocessor, serial to parallel unit and MUX are working.

10.1.4 Output Conversion Module Testing

Test Case	T7 – LED testing
Description	This test determines if LEDs are supplied enough power to give a visual indication to the user. The test involves testing the microprocessor and serial to parallel are working in sync.

10.1.5 System Function Testing

Test Case	T8 – Basic induction heating functionality
Description	This test determines if the overall system is working properly, The test involve heating, cooling and temperature accuracy of Smart-Stove.

10.2 System Performance Testing

In the system performance testing, Thermopix Inc. will ensure that Smart Stove meets all the requirements listed in functional specifications such as temperature and pan sensing response time, temperature adjustment conversion time, and LEDs lighting and flashing mechanism. The details of relevant performance tests are categorized into specific design modules.

The system performance testing will be performed module by module to specify if each module achieve its desired design specifications.

References

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Table of Glossary

PCB – Printed Circuit Board

SMPS – Switched-mode Power Supply

DC – Direct Current

AC – Alternating Current

MICOM – Micro Computer, microprocessor

IGBT – Insulated-gate Bipolar Transistor

IC – Integrated Circuit

LED – Light-emitting Diode

REP – Rated Electric Power

LCD – Liquid Crystal Display

CFM – Cubic Feet per Minute

RPM – Revolutions per Minute