

# **Diva, Model 10-CT Induction Cooktop Performance Test**

Application of ASTM Standard  
Test Method F 1521-03

FSTC Report 5011.08.02

**Food Service Technology Center  
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Specific appreciation is extended to Diva for supplying the FSTC with the 10-CT induction cooktop for controlled testing in the appliance laboratory.

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# Contents

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	Page
Executive Summary .....	iii
<b>1 Introduction</b> .....	<b>1-1</b>
Background .....	1-1
Objectives .....	1-2
Appliance Description .....	1-2
<b>2 Methods</b> .....	<b>2-1</b>
Setup and Instrumentation .....	2-1
Energy Input Rate .....	2-1
Heat-up Temperature Response and Temperature Uniformity ...	2-1
Cooking-Energy Efficiency and Production Capacity .....	2-2
<b>3 Results</b> .....	<b>3-1</b>
Energy Input Rate .....	3-1
Heat-up Temperature Response and Temperature Uniformity ...	3-1
Cooking-Energy Efficiency and Production Capacity .....	3-3
<b>4 Conclusions</b> .....	<b>4-1</b>
<b>5 References</b> .....	<b>5-1</b>
<b>Appendix A: Glossary</b>	
<b>Appendix B: Appliance Specifications</b>	
<b>Appendix C: Results Reporting Sheets</b>	
<b>Appendix D: Cooking-Energy Efficiency Data</b>	

# List of Figures and Tables

---

## Figures

	<b>Page</b>
1-1 Diva 10-CT Cooktop .....	1-3
3-1 Heat-up Temperature Response at Minimum and Maximum Settings .....	3-1
3-2 Temperature Uniformity at Minimum Setting .....	3-2
3-3 Temperature Uniformity at Maximum Setting .....	3-3
3-4 Energy Rate vs. Production Rate .....	3-4

## Tables

	<b>Page</b>
1-1 Appliance Specifications .....	1-3
3-1 Temperature Uniformity Results .....	3-2
3-2 Cooking-Energy Efficiency and Production Capacity Results .....	3-3

## Executive Summary

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The DIVA 10-CT is a free-standing, single hob, countertop induction cooktop with a maximum input rating of 3.6 kW. Controls include 12 power levels plus a boost setting to achieve maximum input. The cooktop is protected by an over-heat safety feature to prevent damage to the unit.

FSTC researchers tested the cooktop under the tight specifications of the American Society for Testing and Materials' (ASTM) standard test method.<sup>1</sup> Cooktop performance was characterized by heat-up temperature response, temperature uniformity, cooking-energy efficiency and production capacity.

As specified by the ASTM test method, cooking-energy efficiency is a measure of how much of the energy consumed by the appliance is delivered to the water and the pot during the cooking process. Cooking-energy efficiency is therefore defined by the following relationship:

$$\text{Cooking - Energy Efficiency} = \frac{\text{Energy to Water \& Pot}}{\text{Energy to Appliance}}$$

A summary of the ASTM test results is presented in Table ES-1.

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<sup>1</sup> American Society for Testing and Materials. 2003. *Standard Test Method for Performance of Range Tops*. ASTM Designation F 1521-03, in *Annual Book of ASTM Standards*, West Conshohocken, PA.

# Executive Summary

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*Table ES-1. Summary of 10-CT Induction Cooktop Performance Results.*

Rated Energy Input Rate (kW)	3.6
Measured Energy Input Rate (kW)	3.5
Cooking-Energy Efficiency (%)	83.6 ± 1.4
Production Capacity <sup>c</sup> (lb/h)	58.7 ± 3.2
Average Temperature at Minimum Setting (°F)*	168.6
Average Temperature at Maximum Setting (°F)*	446.1

\*After 1 hour.

The Diva 10-CT induction cooktop produced solid performance numbers under the rigorous conditions of the ASTM test method. By utilizing induction heating, the unit exhibited a higher cooking-energy efficiency and higher production capacity than standard resistance heater electric range tops.

In addition to higher efficiencies, induction technology also saves energy through automatic utensil recognition. The 10-CT interrupts power to the induction coils when the cooking container is removed, effectively creating an active energy management system. The unit only consumes energy when a suitable container is placed on the cooktop, unlike a standard range top that consumes energy until being shut off manually.

Through the use of induction technology, Diva produced a cooktop that combines the positive performance and energy traits of both standard gas and electric range tops. The 10-CT had the quick temperature response that is characteristic of gas range tops while exhibiting the higher energy efficiency attributed to electric range tops.

# 1 Introduction

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## Background

Range tops are one of the most widely used and versatile pieces of equipment in a commercial kitchen and are produced in a wide array of configurations. While gas remains the dominant fuel source for range tops, one often overlooked technology is electric induction heating. Although induction heating has been around for many years and is very popular in Europe, its application to commercial cooking has been limited in North America.

Induction range tops use electromagnetic energy to heat cookware made of magnetic material (steel, iron, nickel or various alloys). When the unit is turned on, the coils produce a high frequency alternating magnetic field, which ultimately flows through the cookware. Molecules in the cookware move back and forth rapidly, causing the cookware to become hot and cook the food.

Induction heating promises many benefits including increased efficiency, precise temperature control, low appliance surface temperatures, reduced heat gain to the surrounding space and easy cleaning.

In 1994, the Food Service Technology Center (FSTC) developed a standard test method to quantify the performance of range tops. This test method was applicable to both gas and electric range tops, and allowed manufacturers and end users to compare performance indices such as cooking-energy efficiency, temperature response, temperature uniformity, and production capacity.

The test method was subsequently approved as an American Society for Testing and Materials (ASTM) standard test method. In 2001, the test method was re-submitted and now carries ASTM designation F1521-03.<sup>1</sup> The Food Service Technology Center report, *Development and Validation of a Uniform Testing Procedure for Range Tops* documents the developmental procedures and preliminary test results for five (two gas and three electric) range tops.<sup>2</sup>

# Introduction

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Other Food Service Technology Center reports document results of applying the ASTM test method to different range tops.<sup>3-11</sup>

The glossary in Appendix A is provided so that the reader has a quick reference to the terms used in this report and Appendix B includes the full specification sheet for the 10-CT.

## Objectives

The objective of this report is to examine the operation and performance of the Diva 10-CT countertop induction cooktop under the controlled conditions of the ASTM standard test method. The scope of this testing is as follows:

1. Verify that the appliance is operating at the manufacturer's rated energy input.
2. Characterize the unit's minimum and maximum temperature rise and temperature uniformity.
3. Document the cooking energy efficiency and production capacity at the maximum setting.

## Appliance Description

The DIVA 10-CT is a free-standing, single hob, countertop induction cooktop with a maximum input rating of 3.6 kW. Controls include 12 power levels plus a boost setting to achieve maximum input. The burner is protected by an over-heat safety feature to prevent damage to the unit. The Diva 10-CT cooktop is shown in Figure 1-1. Appliance specifications are listed in Table 1-1, and the manufacturer's literature is included in Appendix B.

# Introduction

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*Figure 1-1.  
Diva 10-CT Cooktop.*

*Table 1-1. Appliance Specifications.*

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Manufacturer	Diva
Model	10-CT
Generic Appliance Type	Single Hob Induction Cooktop
Rated Input	3.6 kW, 208-240V single phase
Controls	Electronic Touchpad with LED Display
Dimensions	15 1/2" x 11 3/4" x 3 1/2"
Weight	21 lbs.

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## 2 Methods

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### Setup and Instrumentation

FSTC researchers installed the induction cooktop under a 4-foot deep canopy hood that was 6 feet, 6 inches above the floor. The hood operated at a nominal exhaust rate of 300 cfm per linear foot of hood. There was at least 6 inches of clearance between the vertical plane of the cooktop and the edge of the hood. All test apparatus were installed in accordance with the ASTM test method.<sup>1</sup>

Power and energy were measured with a calibrated watt/watt-hour transducer that generated an analog signal for instantaneous power and a pulse for every 10 Wh. Cooktop temperature rise and uniformity were measured with K-type thermocouples welded to a 12-inch diameter, ¼" thick steel plate. Water temperature was measured using a beaded-end, K-type thermocouple wire. The transducer and thermocouples were connected to an automated data acquisition unit that recorded data every 5 seconds. A voltage regulator was used to maintain a constant 220 volts for all tests.

### Energy Input Rate

The input rate was measured at 220V with the unit operating at full input (boost setting) in order to verify that the cooktop was operating properly, within  $\pm 5.0\%$  of the manufacturer's rated input.

### Heat-up Temperature Response and Temperature Uniformity

To determine the heat-up temperature response of the cooktop, FSTC researchers attached 17 thermocouples to a ¼ -inch-thick, 12-inch-diameter carbon steel plate, as detailed in section 10.4 of the ASTM test method. The cooktop was set to the minimum control setting (level 1) and time, temperature, and energy were recorded over the next hour. After the plate was allowed to cool, the test was repeated at the highest (boost) setting.

## Methods

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### Cooking-Energy Efficiency and Production Capacity

Temperature uniformity of the cooktop was determined by recording the 17 individual temperatures on the plate surface at the end of each one-hour heat-up temperature response test. The temperature uniformity was then expressed as the standard deviation of these temperature points and was reported along with the average of the entire plate.

The cooking energy efficiency and production capacity test was determined by heating 20.0 lbs of water in a stock pot from 70°F to 200°F, using the maximum (boost) setting. The cooking container used for the cooking-energy efficiency tests was a stainless steel, 12 qt. capacity, 13" diameter stock pot covered by an aluminum lid. The pot weighed 12.00 pounds and the lid weighed 1.30 pounds. Three cooking tests were performed in accordance with the ASTM test method, which ensured that the reported cooking energy efficiency and production capacity result had an experimental uncertainty of less than  $\pm 10.0\%$ . The results from each test run were averaged, and the absolute uncertainty was calculated based on the standard deviation of the results.

Appendix C contains the ASTM results reporting sheets for the 10-CT cooktop.

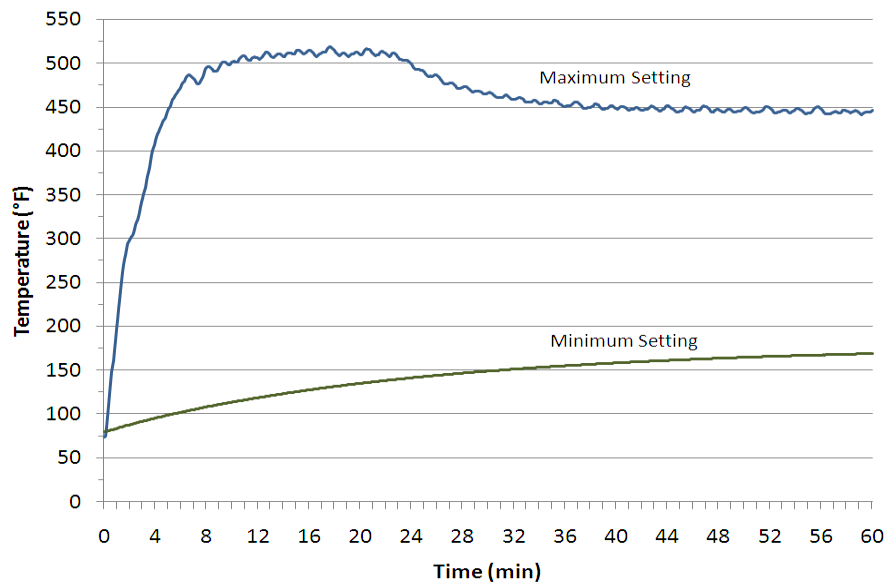
### 3 Results

#### Energy Input Rate

The measured energy input rate was 3.5 kW at 220V, 3.3% less than the nameplate rating. This confirmed the cooktop was operating properly and testing could proceed without adjustment.

#### Heat-up Temperature Response and Temperature Uniformity

During the minimum setting test, the cooktop consumed energy at an average rate of 0.24 kW. The average temperature of the plate at the end of the one-hour test was 168.6°F. The maximum setting test showed an average energy rate of 0.78 kW. The low energy rate was due to the cooktop's built-in over-heat safety protection. This feature began modulating the induction hob approximately 6.5 minutes into the test to prevent damage to the cooktop. At the completion of the one-hour test period, the average plate temperature was 446.1°F. Figure 3-1 shows the average disk temperature during the tests at both the minimum and maximum settings.



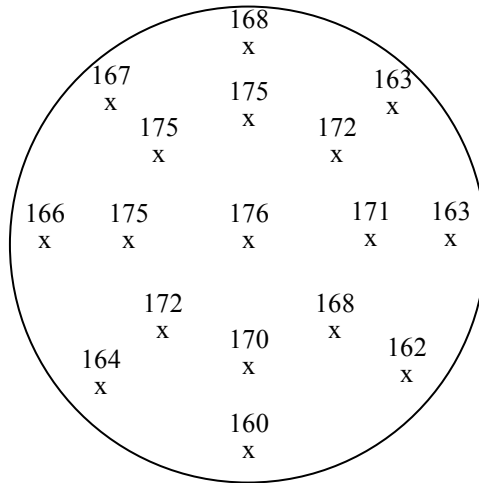
*Figure 3-1.  
Heat-up Temperature  
Response at Minimum  
and Maximum Settings.*

# Results

Table 3-1 summarizes the results of the uniformity tests at the minimum and maximum settings. Figures 3-2 and 3-3 depict the individual temperatures on the temperature uniformity plate, with the bottom of the plate representing the front of the unit.

*Table 3-1. Temperature Uniformity Results.*

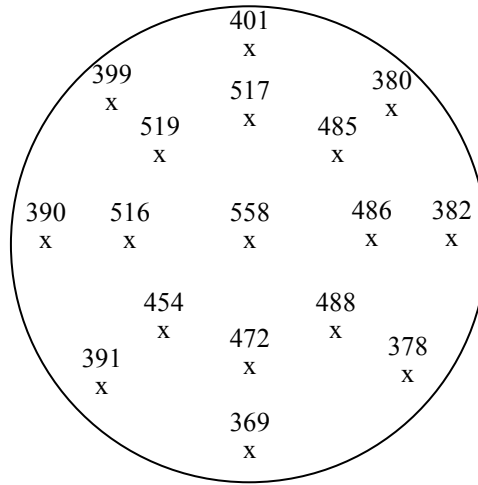
Temperature Setting	Average Temperature	Standard Deviation
Minimum (Level 1)	168.6°F	5.2
Maximum (Boost)	446.1°F	62.7



*Figure 3-2.  
Temperature Uniformity  
at Minimum Setting.*

# Results

---



*Figure 3-3.  
Temperature Uniformity  
at Maximum Setting.*

## Cooking-Energy Efficiency and Production Capacity

Three test runs were performed at full input (boost setting) to determine energy efficiency and production capacity. The results are reported in Table 3-2.

*Table 3-2. Cooking-Energy Efficiency and Production Capacity Results.*

Test Time (min)	20.4
Production Capacity (lb/h)	58.7 ± 3.2
Cooking Energy Rate (Btu/h)	2.9
Cooking-Energy Efficiency (%)	83.6 ± 1.4

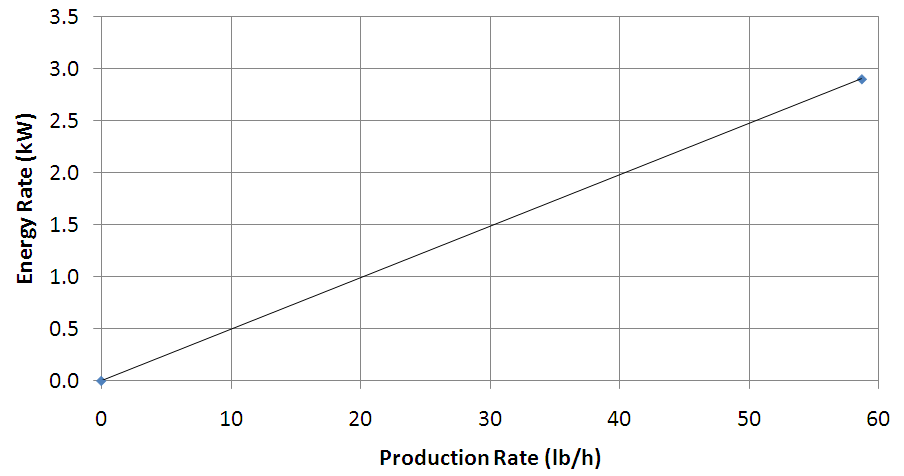
### Test Results

Cooking-energy efficiency results for the three tests were 83.0%, 83.4%, and 84.2%, yielding an uncertainty of 1.7% in the results. Figure 3-4 illustrates the relationship between energy input rate and production rate for the 10-CT cooktop. This information can be used for estimating the cost of operation by determining a production rate for a given input rate.

# Results

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*Figure 3-4.  
Energy Rate vs. Production Rate.*



## 4 Conclusions

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The Diva 10-CT induction cooktop produced solid performance numbers under the rigorous conditions of the ASTM test method. By utilizing induction heating, the unit exhibited a higher cooking-energy efficiency and a faster heat-up temperature response time than standard resistance heater electric range tops.<sup>3-11</sup>

The production capacity of the 10-CT was well above those of standard electric range tops, and, when compared to other induction units, was higher than all but the most powerful model previously tested.<sup>3-11</sup> The uniformity tests showed less temperature variation than other induction units at both minimum and maximum settings, and that the 10-CT could be adjusted to a lower temperature than standard gas and electric ranges.<sup>3-11</sup>

In addition to higher efficiencies, induction technology also saves energy through automatic utensil recognition. The 10-CT interrupts power to the induction coils when the cooking container is removed, effectively creating an active energy management system. The unit only consumes energy when a suitable container is placed on the cooktop, unlike a standard range top that consumes energy until being shut off manually.

Through the use of induction technology, Diva produced a cooktop that combines the positive performance and energy traits of both standard gas and electric range tops. The 10-CT had the quick temperature response that is characteristic of gas range tops while exhibiting the higher energy efficiency attributed to electric range tops.

## 5 References

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# A Glossary

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## Cooking-Energy (kWh or kBtu)

The total energy consumed by an appliance as it is used to cook a specified food product.

## Cooking-Energy Consumption Rate (kW or kBtu/h)

The average rate of energy consumption during the cooking period.

## Cooking-Energy Efficiency (%)

The quantity of energy input to the food products; expressed as a percentage of the quantity of energy input to the appliance during the heavy-, medium-, and light-load tests.

## Duty Cycle (%)

Load Factor

The average energy consumption rate (based on a specified operating period for the appliance) expressed as a percentage of the measured energy input rate.

$$\text{Duty Cycle} = \frac{\text{Average Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

## Energy Input Rate (kW or kBtu/h)

Energy Consumption Rate

Energy Rate

The peak rate at which an appliance will consume energy, typically reflected during preheat.

## Heating Value (Btu/ft<sup>3</sup>)

Heating Content

The quantity of heat (energy) generated by the combustion of fuel. For natural gas, this quantity varies depending on the constituents of the gas.

## Idle Energy Rate (kW or Btu/h)

Idle Energy Input Rate

Idle Rate

The rate of appliance energy consumption while it is holding or maintaining a stabilized operating condition or temperature at a specified control setting.

## Idle Temperature (°F, Setting)

The temperature of the cooking cavity/surface (selected by the appliance operator or specified for a controlled test) that is maintained by the appliance under an idle condition.

## Idle Duty Cycle (%)

Idle Energy Factor

The idle energy consumption rate expressed as a percentage of the measured energy input rate.

$$\text{Idle Duty Cycle} = \frac{\text{Idle Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

# Glossary

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## Measured Input Rate (kW or Btu/h)

Measured Energy Input Rate  
Measured Peak Energy Input Rate

The maximum or peak rate at which an appliance consumes energy, typically reflected during appliance preheat (i.e., the period of operation when all burners or elements are “on”).

## Pilot Energy Rate (kBtu/h)

Pilot Energy Consumption Rate

The rate of energy consumption by the standing or constant pilot while the appliance is not being operated (i.e., when the thermostats or control knobs have been turned off by the food service operator).

## Preheat Energy (kWh or Btu)

Preheat Energy Consumption

The total amount of energy consumed by an appliance during the preheat period.

## Preheat Rate (°F/min)

The rate at which the cook zone heats during a preheat.

## Preheat Time (minute)

Preheat Period

The time required for an appliance to “pre-heat” from the ambient room temperature ( $75 \pm 5^\circ\text{F}$ ) to a specified (and calibrated) operating temperature or thermostat set point.

## Production Capacity (lb/h)

The maximum production rate of an appliance while cooking a specified food product in accordance with the heavy-load cooking test.

## Production Rate (lb/h)

Productivity

The average rate at which an appliance brings a specified food product to a specified “cooked” condition.

## Rated Energy Input Rate

(kW, W or Btu/h, Btu/h)

Input Rating (ANSI definition)

Nameplate Energy Input Rate

Rated Input

The maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

## Recovery Time (minute, second)

The average time from the removal of the cooked food product from the appliance until the cooking cavity is within  $10^\circ\text{F}$  of the thermostat set point and the appliance is ready to be reloaded.

## Test Method

A definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

## **B** Appliance Specifications

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Appendix B includes the product literature for the Diva 10-CT induction cooktop.



**Project Name:** \_\_\_\_\_

**Item Number:** \_\_\_\_\_

**Quantity:** \_\_\_\_\_



**Induction Cooktop  
DIVA 10 CT  
- countertop model -**

Approved by:



**DIVA 10 CT**

**WHY INDUCTION?**

**SAFETY:** Induction heats the cookware, while the surrounding area stays cool to the touch. Built-in safety features include overheat protection, pan recognition, empty pan detection, etc.

**PRECISION:** Digital touch-sensitive control allows for precise power level adjustment - 12 power settings, from 50 W to 3600 W. Ideal for all types of cooking: from melting chocolate to stir fry. Induction is known and appreciated for lowest heat inertia and prompt heat level change.

**POWER & EFFICIENCY:** Considerably faster heat source compared to other cooking technologies.

**ENVIRONMENT FRIENDLY:** Induction is the most economical and energy conserving cooking technology. Minimal ambient heat rejection makes the kitchen cooler and reduces need for ventilation and air conditioning

**FLEXIBILITY:** Cooktops are light and portable and can be used for cooking in versatile set-ups from kiosks and buffet stations to the kitchens of the world's greatest chefs.

**EASE OF CLEANING:** Surface simply wipes clean after use.

**SUITABLE COOKWARE**

Induction will work with pans having a ferritic base, such as cast iron, enameled and induction grade pans. Recommended cookware size diameter: 100 - 330 mm [4" - 13"].

**FEATURES**

Countertop unit in low-profile stainless steel casing with flush-fitted cooking surface and touch control pad in vitroceramic glass. Unit sits on four rubber feet.

Power: 3.6 kW

Electrical connection: 220 V, 2 Pole+G, 20 A, unit equipped with 1.8 m (6') long cord and NEMA 6-20P plug.

One cooking zone with two concentric coils:

- inner Ø180 mm [7"], and
  - outer Ø 180-280 mm [7"-11"],
- with electronic recognition and override for single or double coil usage.

Touch-sensitive capacitive-type controls: ON/OFF, +/- power level adjustment, three preset power level controls and BOOST control.

Electronic utensil recognition with automatic shut-off when utensil is not detected or removed.

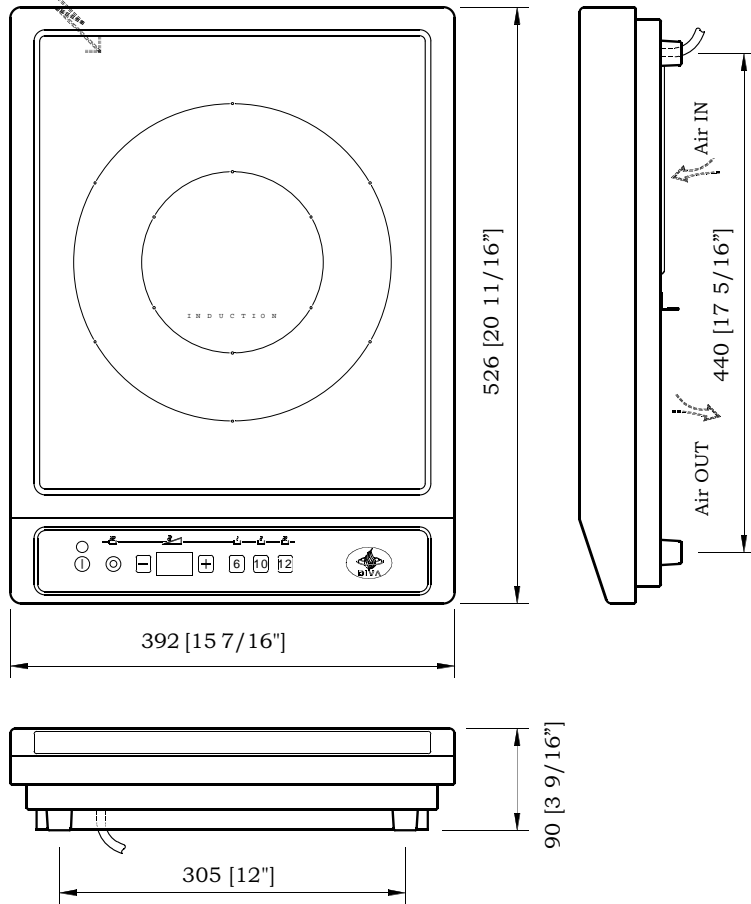
Safety features: utensil temperature monitoring and power-level modulation, utensil recognition, internal component over-heat protection.

On-board cooling fan with removable air intake filter.

Complies with:

- UL 197;
- CAN/CSA-E335-2-36-94;
- NSF 4;
- FCC - CFR 47, Part 18.

220 V, 2 Pole+G, 20 A



**Induction Cooktop  
Diva 10 CT  
- countertop model -**

**INSTALLATION**

**The unit must be installed and used in accordance with local building, trade, fire protection and electrical codes. If local codes do not exist, then installation must be done in accordance with federal codes.**

The cooktop is to be plugged into an adequate receptacle or 'hard-wired' inside a junction box. **The unit must be properly grounded.**

The clearance to any combustible surface above the unit must be min. **900 mm [36"]**.

The unit must be placed on flat and stable surface. When installing/placing the cooktop, proper air flow for the cooling fan, which is positioned on the bottom of unit, must not be restricted.

**SHORT FORM SPECIFICATIONS**

Supply induction cooktop by Diva de Provence, DIVA 10 CT, countertop unit, 3.6 kW, 220 V, 2 Pole+G. Stainless steel casing with feet. Vitroceramic cooking surface and vitroceramic pad for controls. Cooktop equipped with touch-sensitive controls. One cooking zone, 280 mm [11"], with two concentric coils. Cooktop equipped with 1.8 m [6'] long cord and plug NEMA 6-20P.

**TECHNICAL SPECIFICATIONS**

Dimensions: 392 x 526 x 90 mm  
[15 7/16" x 20 11/16" x 3 9/16"]

Glass size: 340 x 405 mm [13 3/8" x 16"]

Inductor - coil - size: Ø 280 mm [11"]

Net weight: 9.4 kg [21 lb]

Package size: 495 x 625 x 140 mm  
[19 1/2" x 24 5/8" x 5 1/2"]

Gross weight: 10.8 kg [24 lb]

Cooktop electrical characteristics are:

Voltage ..... 220 V ~ 60 Hz

Max. power ... 3600 W - boost setting

Min. power .... 50 W - setting '1'

Plug type ..... NEMA 6-20P

Connect to ... 220 V, 60 Hz, 2 Pole+G, 20 A  
(NEMA 6-20R)

# C Results Reporting Sheets

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## Test Oven Description

Manufacturer: Diva  
Model Number: 10-CT  
Date: December 2007

### 1. Test Range (11.1)

Type: Electric Induction  
Rated Input: 3.6 kW  
Controls: Electronic touchpad with L.E.D. display.

Description of operational characteristics:

The Diva 10-CT is an electric, single hob countertop induction cooktop with a rated energy input of 3.6 kW. An electronic touchpad control adjusts power level. Automatic utensil recognition with auto shutoff interrupts power when no cooking vessel is present. Over-heat protection with power modulation protects internal components from damage if cooking vessels are boiled dry.

### 2. Apparatus (11.2)

Check if testing apparatus conformed to specifications in Section 6.

Deviations: Pot used was 13-inch diameter, 20 quart capacity, induction-ready stainless steel pot.

### 3. Energy Input Rate (11.4)

Test Voltage	220
Gas heating value (Btu/ft <sup>3</sup> )	N/A
Measured (Btu/h or kW)	3.5
Rated (Btu/h or kW)	3.6
Percent difference between measured and rated (%)	3.3

### 4. Pilot Energy Consumption (11.5)

Gas heating value (Btu/ft <sup>3</sup> )	N/A
Pilot energy rate (Btu/h or kW)	N/A

# Results Reporting Sheets

## 5. Heat-Up Temperature Response and Temperature Uniformity at Maximum and Minimum Control Settings (11.6)

Test voltage (V)	220
Energy rate at Minimum Setting (Btu/h or kW)	0.24
Average Final Temperature at Minimum Setting (°F)	168.6
Energy rate at Maximum Setting (Btu/h or kW)	0.78
Average Final Temperature at Maximum Setting (°F)	446.1

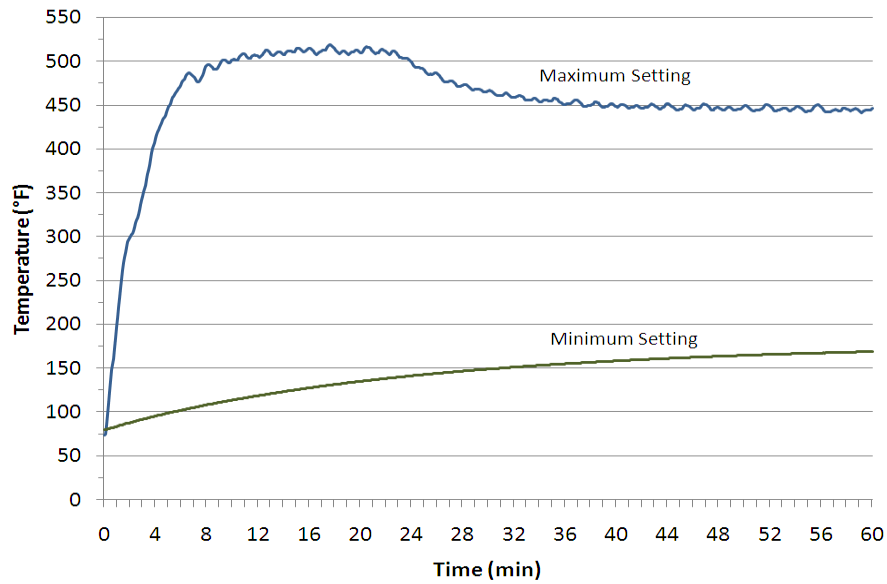


Figure C-1. Heat-up Temperature Response at Minimum and Maximum Settings.

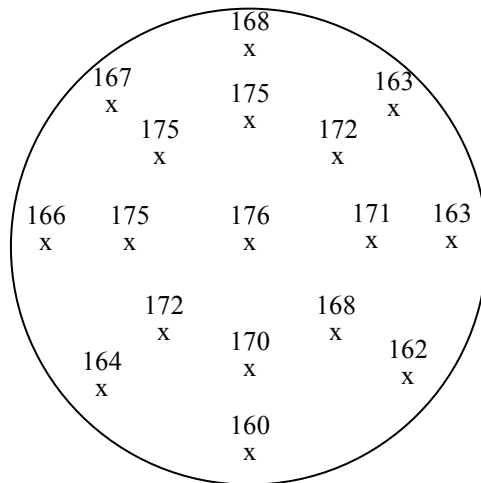


Figure C-2. Temperature Uniformity at minimum setting.

# Results Reporting Sheets

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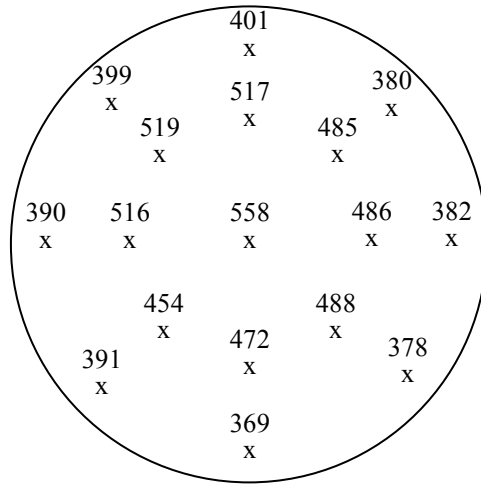


Figure C-3. Temperature Uniformity at maximum setting.

## 6. Cooking-Energy Efficiency and Production Capacity (11.7)

Test voltage (V)	220
Gas heating value (Btu/ft <sup>3</sup> )	N/A
Test time (min)	20.4
Production rate (lb/h)	58.7 ± 3.2
Cooking energy rate (Btu/h or kW)	2.9
Cooking-energy efficiency	83.6 ± 1.4

## D Cooking-Energy Efficiency Data

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*Table D-1. Specific Heat.*

Specific Heat (Btu/lb, °F)	
Water	1.00
Stainless Steel	0.11
Aluminum	0.22

*Table D-2. Cooking-Energy Efficiency Test Data.*

	Test #1	Test #2	Test #3
<b>Measured Values</b>			
Energy to Cooktop (kWh)	0.992	0.981	0.972
Cook Time (min)	20.3	20.8	20.2
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	12.00	12.00	12.00
Weight of Container Lid (lb)	1.3	1.3	1.3
Initial Temperature of Water (°F)	70.2	70.7	71.0
Final Temperature of Water (°F)	200.4	200.0	200.3
<b>Calculated Values</b>			
Energy to Water (Btu)	2604	2586	2586
Energy to Cooking Container & Lid (Btu)	209	208	208
Energy to Cooktop (Btu)	3386	3348	3317
<b>Cooking-Energy Efficiency (%)</b>	<b>83.1</b>	<b>83.4</b>	<b>84.2</b>
<b>Cooking Energy Rate (kW)</b>	<b>2.9</b>	<b>2.8</b>	<b>2.9</b>
<b>Production Rate (lb/h)</b>	<b>59.1</b>	<b>57.7</b>	<b>59.4</b>

## Cooking-Energy Efficiency Data

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*Table D-3. Cooking-Energy Efficiency and Production Capacity Statistics.*

	Cooking-Energy Efficiency	Production Capacity
Replicate #1	83.1	59.1
Replicate #2	83.4	57.7
Replicate #3	84.2	59.4
<b>Average</b>	<b>83.6</b>	<b>58.7</b>
Standard Deviation	0.57	0.92
Absolute Uncertainty	1.43	3.19
Percent Uncertainty	1.71	5.43

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