# BEC INCORPORATED

## ELECTROMAGNETIC EMISSION TEST REPORT

**TEST STANDARD: Federal Communications Commission Title 47, Part 18**

**Device Under Test: SPI Supplies Plasma Prep III**
**Plasma Etcher**

**REPORT#: BEC-1066-1**

**TEST DATES: 03/03/09 to 03/24/09**

**ISSUE DATE: 03/30/09**

**PREPARED BY:** _____

Tony Mauriello, NARTE Certified EMC Engineer

**REVIEWED BY:** _____

Al Fanella, Test Director



ACCREDITED
Certification No. 2597.01

## TABLE OF CONTENTS

# 1.0 Administrative Information

## 1.1 Description of the Device under Test (DUT)

| | |
|---|---|
| **Project Number** | BEC-1066 |
| **Equipment Identification** | 1066-01 |
| **Model Number** | Plasma Prep III |
| **Serial Number** | Proto#1 |
| **Test Location** | BEC Incorporated<br>970 East High Street<br>Pottstown, PA 19464<br>Certifications: A2LA Cert. No 2597.01;<br>FCC OATS Reg. No. 922038 |
| **Test Performed For** | SPI Supplies<br>569 East Gay Street<br>West Chester, PA 19380 |
| **Test Personnel** | Steve Fanella/Al Fanella |
| **Technical Contact** | Al Meyer |
| **Date Received** | 03/03/09 |
| **Condition Received** | Suitable for test |
| **Sample Type** | Production Unit |
| **DUT Classification** | ISM |

## 1.2 Preface

This report documents product testing conducted to verify compliance of the specified DUT with applicable standards and requirements as identified herein. DUT, test instrument configurations, test procedures, and recorded data are generally described in this report. The reader is referred to the applicable test standards for detailed procedures. The following table summarizes the test results obtained during this evaluation.

## 1.3 Summary

The SPI Supplies Plasma Prep III was tested and found to be compliant with the Federal Communications Commission (FCC) Title 47, Part 18.

## 1.4 Measurement Uncertainty

No adjustments to measured data presented in this report are required because all values of uncertainty are less that the CISPR 16-4-2:2003 recommendations. These uncertainties have a coverage factor of $k = 2$, which yields approximately a 95% level of confidence for the near-normal distribution typical of most measurement results.

## 1.5 Test Equipment

All test equipment is checked to manufacturer's specifications and, when applicable, have current N.I.S.T. traceable, ISO 9002 conforming certificates of calibration. Test equipment used for the tests described herein is listed in Appendix A.

## 1.6 Condition of Received Sample

An evaluation of the DUT was conducted in order to verify test subject identity and condition and to ensure suitability for testing. No evidence of physical damage was noted. The test item condition was deemed acceptable for the performance of the requested test services.

## 1.7 General Description

SPI Plasma-Prep III is a compact, "bench-top" sized plasma etcher, which can also serve as a plasma asher or even a plasma cleaner. It uses dry plasma chemistry to reveal hidden detail for SEM and TEM analysis. This room-temperature plasma etching process works selectively, gently - and is well-suited for many applications in the EM lab, including work in: life sciences, materials science, electronics, AEM, failure analysis and general electron microscopy, including asbestos sample preparation. Additionally, it is also widely used for the cleaning before use of microscope slides, both glass and quartz, and it is also used for the cleaning of transmission cells for a variety of different types of spectroscopic instrumentation.

The device is approximately 11" h. x 12" w. x 14" d. and operates from 95V to 240 V AC, 50/60 Hz (no change for different voltages). Power consumption is 100 watts +/- 2 watts. The main oscillator is 13.56 MHz and the microprocessor clock is 18.432 MHz.

# 2.0 Equipment under Test

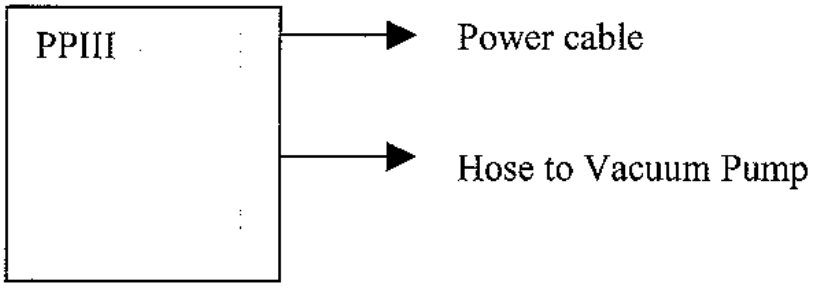
Unless otherwise noted in the individual test results sections, testing was performed on the DUT as follows.

## 2.1 Test Configuration Rationale

The tested configuration with the tray motor exercised represents the highest levels of activity for Emissions. The software which monitored the DUT for temperature changes and communication between the DUT and PC represented the best way to monitor the DUT for proper operation.

## 2.2 Test Configuration Diagram

A block diagram of the DUT configuration is illustrated below.




**Interconnection Cable List**

| Type | Shielding | Length | Description |
|---|---|---|---|
| 1.5 Inch | None | 15 Ft | Rubber Hose Connected to Vacuum Pump |
| SJT | None | 6 Ft | Longwell-P 152192 AC Power Cord |

**DUT Hardware**

| Description | Manufacturer | Model | Serial Number |
|---|---|---|---|
| Plasma Etcher | SPI Supplies | Plasma Prep III | Proto#1 |

**Support Equipment**

| Description | Manufacturer | Model | Serial Number |
|---|---|---|---|
| High Vacuum Pump | Edwards | E2M5FF | M527720 |

## 2.3 Climatic Environment

Unless noted elsewhere in this report, the following were the ambient conditions in the laboratory during testing:

Temperature: 22 ° ± 5 °
Humidity: 50% ± 20%
Atmospheric Pressure: 96 kPa ±10 kPa
Note: This represents an altitude of approximately -1,200 to 4,500 feet above sea level. For all practical purposes, verification of site pressure before testing is unnecessary.

## 2.4 Selection of AC Power Voltages/Frequencies

The operating power of the DUT for testing was 120 VAC /60 Hz.

## 2.5 Operating Mode

The SPI Plasma Prep III Plasma Etcher operated at full forward and reverse RF power. RF Forward was set @ 100 and RF Reverse was set @ 0. The DUT was connected to a vacuum pump to create the vacuum required for functional DUT operation.

## 2.6 Performance Verification During Emission Testing

The SPI Plasma Prep III Plasma Etcher was monitored to ensure that the RF power level indicated on the front panel display did not change. The DUT was also monitored to verify that it did not lose operational power.

## 2.7 DUT Modifications

No modifications were necessary for the SPI Supplies Plasma Prep III to meet the EMI requirements.

## 2.8 SPI Supplies Plasma Prep III DUT Picture

# 3.0 Applicable Requirements, Methods, and Procedures

## 3.1 Applicable Requirements

FCC Title 47, Part 2 and Part 18 as follows:

### *§ 18.301 Operating frequencies.*

ISM equipment may be operated on any frequency above 9 kHz except as indicated in §18.303. The operating frequency of the DUT, 13.56 MHz, +/- 7 kHz, is allocated for use by ISM equipment.

### *§ 18.305 Field strength limits.*

(a) ISM equipment operating on a frequency specified in §18.301 is permitted unlimited radiated energy in the band specified for that frequency.

(b) The field strength levels of emissions which lie outside the bands specified in §18.301, unless otherwise indicated, shall not exceed the following:

| Equipment | Operating frequency | RF Power generated by equipment (watts) | Field strength limit (uV/m) | Distance (meters) |
|---|---|---|---|---|
| Any type unless otherwise specified (miscellaneous) | Any ISM frequency | Below 500<br>500 or more | 25<br>25×SQRT(power/500) | 300<br>[1]300 |
| | Any non-ISM frequency | Below 500<br>500 or more | 15<br>15×SQRT(power/500) | 300<br>[1]300 |

[1]Field strength may not exceed 10 µV/m at 1600 meters.

### *§ 18.307 Conduction limits.*

For certain equipment, when designed to be connected to the public utility (AC) power line the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies shall not exceed applicable limits.. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal using a 50 µH/50 ohms line impedance stabilization network (LISN).

Non-consumer products like the DUT are exempt from these requirements.

## 3.2 Basic Test Methods and Procedures

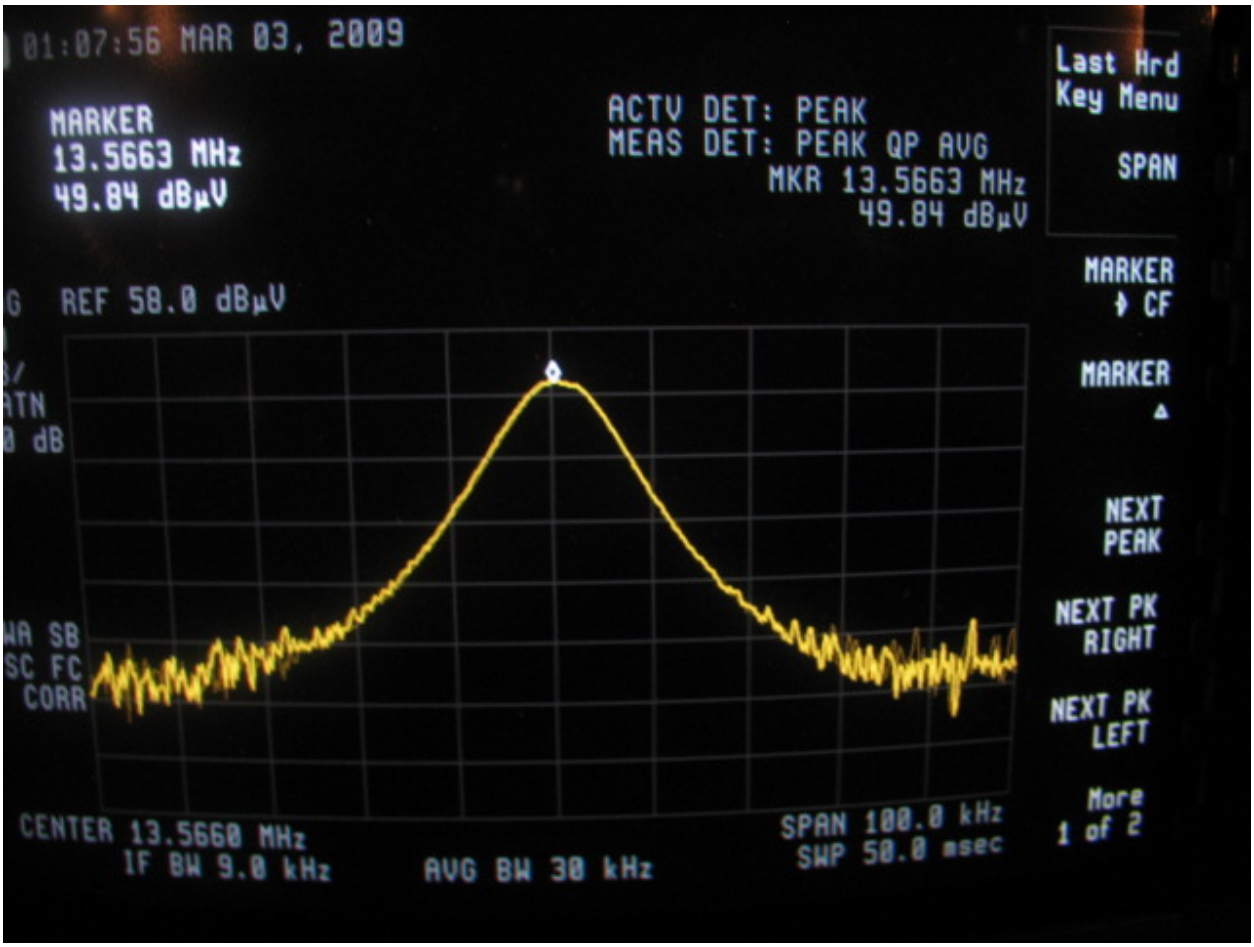
The measurement techniques which were used in the conduct of the tests reported herein are set out in FCC Measurement Procedure MP–5, "Methods of Measurements of Radio Noise Emissions from ISM equipment".

## 3.3 Deviations or Exclusions from the Requirements

No deviations or exclusions were made.

# 4.0 Test Results

## 4.1 Plasma Prep III ISM Frequency Data




**Results:** The SPI Supplies Plasma Prep III ISM frequency was 13.5663MHz which was within the ± 7 kHz specified in FCC Part 18 Section 18.301

## 4.2 Radiated Emissions

### 4.2.1 Test Facility

The Open Area Test Site (OATS) is an all weather facility with a wooden enclosure that contains a ground level 4-foot diameter turntable capable of rotating equipment 360 degrees. The enclosure is free of reflective metallic objects and extraneous electromagnetic signals. This non-metallic enclosure and the 3 and 10 meter test range existing outside the enclosure rest upon a protective insulating material, which in turn covers a flat, metal, continuous ground plane.

Instrumentation for remote control of the antenna mast, turntable, and other equipment are controlled by personnel indoors. The DUT and support peripherals required for DUT operation were placed on a table 80 cm high for tabletop equipment or directly on the turntable surface for floor standing equipment.

The test site complies with the attenuation measurements specified in ANSI C63.4 and CISPR 11.

### 4.2.2 Radiated Emissions Test Procedure

Preliminary measurements from 30 to 1000 MHz were made using a Gigahertz Transverse Electromagnetic (GTEM) cell or semi-anechoic chamber to identify predominant emission frequencies from the DUT and to find the DUT configurations and/or modes that produced the maximum amount of emissions.

The EMI receiver was set to quasi-peak mode and the appropriate CISPR bandwidths were employed. Significant emissions found during the preliminary scan were maximized by rotating the turntable 360 degrees and varying the antenna height from 1 m to 4 m. Both horizontal and vertical antenna polarities were also investigated for suspect emissions. The support equipment and test item(s) were powered off in turn to determine the source of the emissions where appropriate. Field strengths were calculated as follows:

Field Strength (dBµV/m) = Meter Reading (dBµV) + Antenna Factor (dB/m) + Cable Loss (dB) – Amplifier Gain (dB)

### 4.2.3 Radiated Emissions Test Results, FCC Part 18, 9kHz to 30MHz (03/09/09)

The following table shows the highest amplitude field strengths as recorded from the DUT. These measurements were performed over the frequency range of 9 kHz to 30 MHz at a distance of 10 meters using a loop antenna and compared to the maximum permissible FCC Part 18 limit adjusted to 10 meters.

| Freq [MHz] | Q-peak [dBµV/m] | Ave [dBµV/m] | Pol | Angle [deg] | Height [cm] | CF [dB] | Limit [dBµV/m] | Margin [dB] | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 13.566 | 34.5 | 33.2 | Perpendicular | 62 | 100 | 11.6 | Unlimited | | PASS |

**Results:** There were no significant signals from the SPI Supplies Plasma Prep III found during the pre-scan of emissions performed in a shielded enclosure. The only measureable frequency was the ISM frequency of 13.566 MHz.

### 4.2.4 Radiated Emissions Test Results, FCC Part 18, 30 to 1000 MHz (03/09/09)

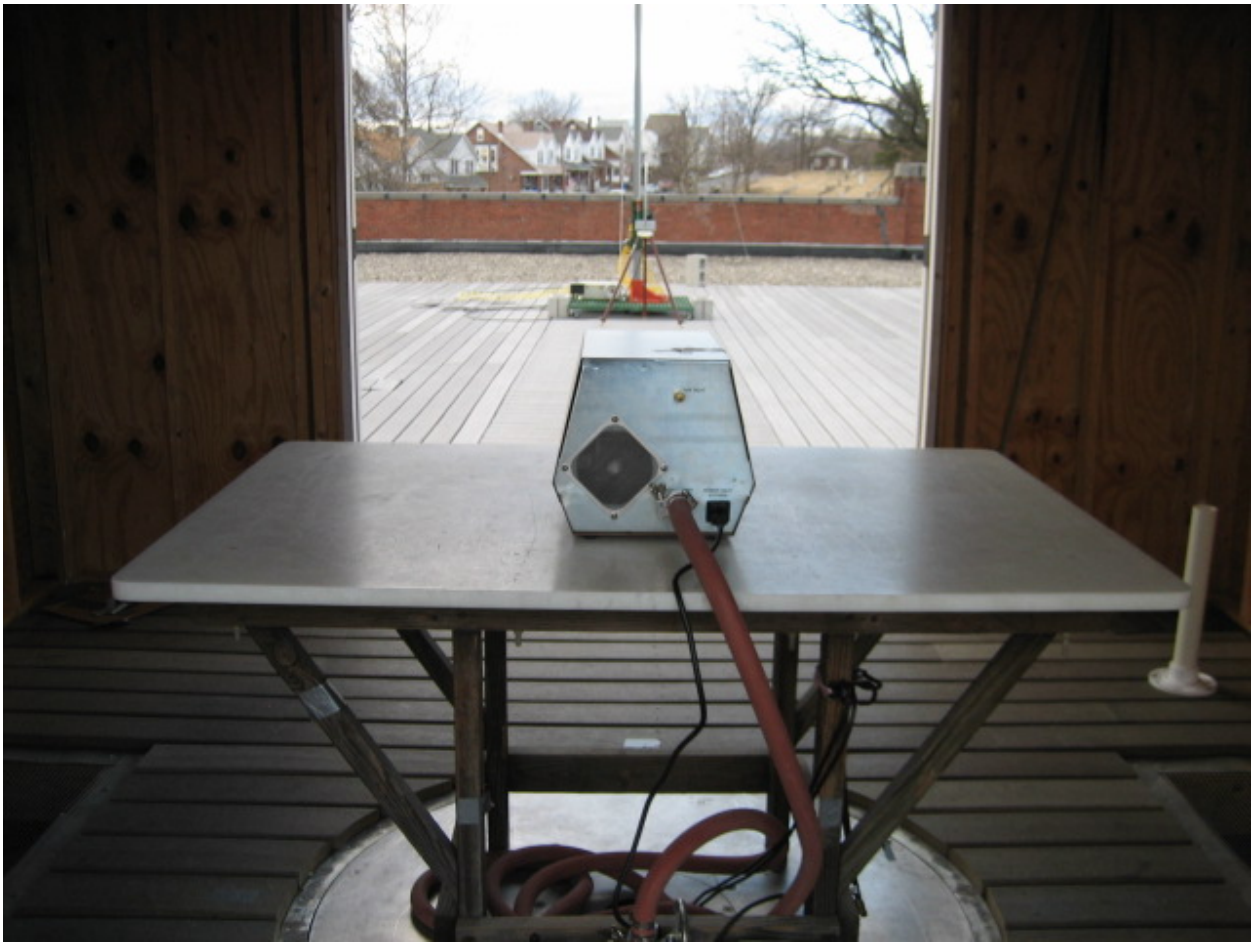
The following table shows the highest amplitude quasi-peak detected field strengths as recorded from the DUT. These measurements were performed over the frequency range of 30 MHz to 1000 MHz at a distance of 10 meters compared to the maximum permissible limit adjusted to 10 meters.

| Freq [MHz] | Peak [dBµV/m] | Q-peak [dBµV/m] | Pol | Angle [deg] | Height [cm] | CF [dB] | Limit [dBµV/m] | Margin [dB] | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 40.699 | 55.41 | 33.09 | V | 359 | 100 | 13.77 | 57.95 | -24.86 | PASS |
| 67.845 | 37.51 | 28.78 | V | 194 | 115 | 8.58 | 57.95 | -29.17 | PASS |
| 94.962 | 39.98 | 33.5 | V | 24 | 106 | 10.37 | 57.95 | -24.45 | PASS |
| 108.545 | 44.26 | 27.31 | V | 359 | 100 | 13.65 | 57.95 | -30.64 | PASS |
| 122.096 | 41.63 | 26.27 | V | 1 | 100 | 14.95 | 57.95 | -31.68 | PASS |
| 258.002 | 29.53 | 14.56 | V | 272 | 100 | 14.6 | 57.95 | -43.39 | PASS |
| 516.078 | 28.71 | 23.7 | V | 11 | 202 | 21.83 | 57.95 | -34.25 | PASS |

**Results:** All radiated emissions from the SPI Supples Plasma Prep III are below the limit specified by FCC Part 18 by a margin of at least 24.45 dB.

**Radiated Emissions 30MHz to 1GHz Test Setup at 10 meters**

**Radiated Emissions 9kHz to 30MHz Test Setup at 10 meters**



# Appendix A – Test Equipment

| Equipment | Manufacturer | Model # | Serial # | BEC # | Calibration Due Date |
|---|---|---|---|---|---|
| EMI Receiver (20 Hz – 26.5 GHz) | Rohde & Schwarz | ESIB 26 | 836119/006 | 1010 | 04/06/09 |
| Antenna (30MHz-6GHz) | Sunol Sciences | JB6 | A022108 | 712 | 04/13/09 |
| GTEM (30 MHz – 1 GHz) | ETS Lindgren | 5317 | 1014 | 1001 | No Cal. Required |
| OATS Site (30 MHz – 1 GHz) | BEC | N/A | N/A | 705 | 04/23/09 |
| Software (Tile Instrument Control System) | Quantum Change/EMC Systems | Version 3 | N/A | NA | No Cal. Required |
| Temp/Humidity Meter | Control Company | 4096CC | 72388702 | 780 | 07/23/09 |
| Anechoic Chamber | Lindgren | 12-2/-2-0 | 4078 | 729 | 10/02/09 |
| EMI Receiver (9KHz-6.5GHz) | Hewlett Packard | 8546A | 3325A00158 | 761 | 04/16/09 |
| Loop Antenna | EMCO | 6502 | 9503-2929 | 1047 | 11/07/09 |