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O P E R A T I N G  M A N U A L




# HVPS/SC™

## 10 kV Electron Beam Deposition Power Supply with Integrated Source Control

PN 074-611-P1B

INFICON

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# HVPS/SC™

## 10 kV Electron Beam Deposition Power Supply with Integrated Source Control

PN 074-611-P1B

INFICON Instruments for Intelligent Control®

www.inficon.com reachus@inficon.com

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Meets the essential safety requirements of the European Union and is placed on the market accordingly. It has been constructed in accordance with good engineering practice in safety matters in force in the Community and does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made.

**Equipment Description:** **HVPS & HVPS-SC (including all options)**

**Applicable Directives:** **2014/30/EU (General EMC)**
**2011/65/EU (RoHS2)**

**Applicable Standards:**

| | |
|---|---|
| **Safety:** | **IEC 61010-1:2010 EDITION 3.0** |
| **Emissions:** | **EN 61326-1: 2013 (Radiated & Conducted Emissions) (EMC – Measurement, Control & Laboratory Equipment) CISPR 11/EN 55011 Edition 2009 (Emission standard for industrial, scientific, and medical (ISM) radio RF equipment)** |
| **Immunity:** | **EN 61326-1: 2013 (Industrial EMC Environments) Immunity per Table 2 (EMC – Measurement, Control & Laboratory Equipment)** |
| **RoHS:** | **Fully Compliant** |

**CE Implementation Date:** **(Revised 5/28/15)**

**Authorized Representative:**

Thin Film Business Line Manager
INFICON, Inc.

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NOTE: These instructions do not provide for every contingency that may arise in connection with the installation, operation or maintenance of this equipment. Should you require further assistance, please contact INFICON.

# Table Of Contents

Cover Page

Title Page

Trademarks

Disclaimer

Copyright

Declaration Of Conformity

Warranty

**Chapter 1**

**Introduction and Specifications**

1.1 Introduction . . . . . 1-1
1.1.1 Thin Film Deposition Controllers and e-Beam Sweep Controller . . . . . 1-1
1.2 Safety . . . . . 1-2
1.2.1 Definition of Notes, Hints, Cautions, and Warnings . . . . . 1-2
1.2.2 General Safety Information . . . . . 1-3
1.3 How To Contact INFICON . . . . . 1-4
1.3.1 Returning HVPS/SC . . . . . 1-4
1.4 HVPS/SC Specifications . . . . . 1-5
1.4.1 Filament Specifications . . . . . 1-5
1.4.2 General Specifications . . . . . 1-5
1.4.3 I/O Specifications . . . . . 1-6
1.4.4 Power Specifications . . . . . 1-6
1.4.5 Operating Environment . . . . . 1-6
1.4.6 Size . . . . . 1-7
1.4.7 Weight . . . . . 1-7
1.5 Unpacking and Inspection . . . . . 1-7
1.6 Configurations . . . . . 1-7
1.6.1 Accessories . . . . . 1-7

**Chapter 2**

**Installation**

2.1 Properly Grounding the e-Beam Vacuum Deposition System . . . . . 2-1
2.1.1 Grounding Requirements . . . . . 2-2
2.1.2 Establishing Earth Ground . . . . . 2-3
2.1.2.1 Alternative Earth Ground . . . . . 2-4
2.1.3 Electric Power Mains Connection . . . . . 2-5

PN 074-611-P1B

2.2 Safety . . . . . 2-7
2.2.1 Lockout/Tagout Procedure . . . . . 2-7
2.2.2 Opening the Chamber . . . . . 2-7
2.2.3 Installation and Maintenance Safety . . . . . 2-8
2.3 Mounting . . . . . 2-9
2.4 Removal . . . . . 2-12
2.5 Rear Panel Description . . . . . 2-13
2.5.1 Network . . . . . 2-14
2.5.2 Digital I/O . . . . . 2-15
2.5.2.1 Relay Outputs . . . . . 2-15
2.5.2.2 Digital Inputs . . . . . 2-16
2.5.3 Analog Input . . . . . 2-16
2.5.4 Source Control . . . . . 2-17
2.5.5 High Voltage Power Cable Connection . . . . . 2-18

**Chapter 3**

**Operation**

3.1 Front Panel Description . . . . . 3-1
3.1.1 Front Panel Indicator Descriptions . . . . . 3-2
3.1.2 USB Connection . . . . . 3-3
3.2 Local and Remote Mode . . . . . 3-3
3.3 Operation . . . . . 3-4
3.4 Runtime Screen . . . . . 3-5
3.5 Editing Output Voltage and Emission Current Values . . . . . 3-7
3.5.1 Editing the Output Voltage . . . . . 3-7
3.5.2 Editing the Emission Current . . . . . 3-8
3.6 Main Menu . . . . . 3-9
3.6.1 Operational Settings Screen . . . . . 3-10
3.6.1.1 Editing a Parameter with Fixed Values . . . . . 3-12
3.6.1.2 Editing a Parameter with Numeric Values . . . . . 3-13
3.6.1.3 Editing Maximum Emission Current . . . . . 3-14
3.6.2 Sound and Display Settings Screen . . . . . 3-15
3.6.3 Status and Diagnostics Screen . . . . . 3-17

**Chapter 4**

**Communications**

4.1 Communications Connections . . . . . 4-1
4.1.1 RS-232/RS-485 Connection . . . . . 4-1
4.1.2 RS-232 Point-to-Point Mode . . . . . 4-1
4.1.3 RS-485 TTL Differential Signaling Mode . . . . . 4-2

PN 074-611-P1B

4.1.4 Electrical . . . . 4-3
4.1.5 RS-485 Line Signal . . . . 4-3
4.1.6 Bit Time . . . . 4-3
4.2 Sycon Multi-Drop Protocol (SMDP) . . . . 4-4
4.2.1 Command Format . . . . 4-4
4.2.1.1 Checksum . . . . 4-6
4.2.1.2 Command Packet Format . . . . 4-6
4.2.1.3 Response Packet Format . . . . 4-7
4.2.2 Optional Serial Command Mode . . . . 4-8
4.2.2.1 Optional Serial Command Format . . . . 4-9
4.3 Communication Library . . . . 4-9
4.3.1 Methods . . . . 4-10
4.3.2 Communication Properties . . . . 4-11
4.3.3 Other Properties . . . . 4-11
4.4 Windows/SMDP Server Implementation . . . . 4-12
4.5 Communications Commands . . . . 4-13
4.5.1 Command: ? . . . . 4-14
4.5.2 Command: @ . . . . 4-14
4.5.3 Command: C/D . . . . 4-14
4.5.3.1 C Parameter: Counters/Statistics . . . . 4-15
4.5.3.2 C/D Parameter: Display/Sound Controls . . . . 4-15
4.5.3.3 C/D Parameter: Operational Controls . . . . 4-16
4.5.3.4 C Parameter: Runtime Results/Feedback . . . . 4-16
4.5.3.4.1 Stop Codes . . . . 4-18
4.5.3.4.2 HVM State Variables . . . . 4-19
4.5.3.5 C/D Parameter: System . . . . 4-20
4.5.3.6 C Parameter: Utility/Special . . . . 4-20
4.5.4 Command: E . . . . 4-21
4.5.5 Command: I . . . . 4-21
4.5.6 Command Examples . . . . 4-22
4.5.6.1 Query System High Voltage . . . . 4-22

**Chapter 5**

**Maintenance and Troubleshooting**

5.1 Maintenance . . . . 5-1
5.2 Troubleshooting . . . . 5-1
5.2.1 General HVPS/SC Troubleshooting . . . . 5-2
5.2.2 Computer Communications Troubleshooting . . . . 5-3
5.2.3 Interlocks . . . . 5-4

PN 074-611-P1B

5.2.4 Error Messages . . . . . 5-5

## Appendix A

## Terminology

A.1 Definitions. . . . . A-1

PN 074-611-P1B

# Chapter 1
# Introduction and Specifications

## 1.1 Introduction

HVPS/SC is a high voltage power supply used in electron beam (e-beam) vacuum deposition systems. HVPS/SC consists of two power supplies within one enclosure:

- The high voltage power supply provides a strong electrostatic field which accelerates electrons emitted from the source filament to the pocket of the deposition source.
- The source control power supply provides current at low voltage for heating the filament to a temperature to produce the desired electron beam emission current.

An external thin film deposition controller can signal HVPS/SC to generate a specific e-beam current by actively modulating the filament current. A magnetic field helps to guide the electron beam to a precise spot in the pocket of the gun.

### 1.1.1 Thin Film Deposition Controllers and e-Beam Sweep Controller

Thin film deposition controllers and an e-beam sweep controller are covered in separate manuals. The following manuals are available on the Thin Film Instrument and Sensor Manuals CD (PN 074-5000-G1), part of the ship kit:

- PN 074-505-P1—IC6 Thin Film Deposition Controller
- PN 074-545-P1—Cygnus 2 Thin Film Deposition Controller
- PN 074-446-P1—XTC/3 Thin Film Deposition Controller
- PN 074-550-P1—SQC-310 Thin Film Deposition Controller
- PN 074-584-P1—IQM-233 Thin Film Deposition Controller
- PN 074-622-P1—EBS-530 e-Beam Sweep Controller

PN 074-611-P1B

## 1.2 Safety

### 1.2.1 Definition of Notes, Hints, Cautions, and Warnings

Before using this manual, please take a moment to understand the Notes, Hints, Cautions, and Warnings used throughout. They provide pertinent information that is useful in achieving maximum instrument efficiency while ensuring personal safety.

**NOTE:** Notes provide additional information about HVPS/SC.

**HINT:** Hints provide insight into HVPS/SC usage.



**CAUTION**

**Failure to obey these messages could result in damage to HVPS/SC.**



**WARNING**

**Failure to obey these messages could result in personal injury.**



**WARNING - Risk Of Electric Shock**

**Dangerous voltages are present, which could result in personal injury.**



**CAUTION - Static Sensitive Device**

**Failure to obey these messages could result in damage to HVPS/SC circuitry.**

PN 074-611-P1B

## 1.2.2 General Safety Information



### WARNING - Risk Of Electric Shock

**Ground strain-relief on the high voltage cable *must be installed to a grounding termination* in vacuum deposition system.**

**Do not open the HVPS/SC case. There are no user-serviceable components within the HVPS/SC case.**

**Dangerous voltages may be present whenever the power cords are present.**



### WARNING

**If HVPS/SC is used in a manner not specified by INFICON, the protection provided by it may be impaired.**

**All maintenance must be performed by qualified personnel.**



### CAUTION - Static Sensitive Device

**HVPS/SC contains delicate circuitry susceptible to transient power line voltages.**

**Ground the high voltage power cable at the filament connections with a grounding rod and grounding clips whenever making or removing interface connections.**



### CAUTION

**This manual should be read in its entirety before attempting to install, remove, or operate HVPS/SC.**

PN 074-611-P1B

## 1.3 How To Contact INFICON

Worldwide customer support information is available under **Support >> Support Worldwide** at www.inficon.com.

- Sales and Customer Service
- Technical Support
- Repair Service

When experiencing a problem with HVPS/SC, please have the following information readily available:

- The Sales Order or Purchase Order number of the HVPS/SC purchase.
- The version of HVPS/SC firmware.
- The version of Windows operating system.
- A description of the problem.
- An explanation of any corrective action that may have already been attempted.
- The exact wording of any error messages that may have been received.

### 1.3.1 Returning HVPS/SC

Do not return any component of HVPS/SC to INFICON before speaking with a Customer Support Representative and obtaining a Return Material Authorization (RMA) number. HVPS/SC will not be serviced without an RMA number.

Packages delivered to INFICON without an RMA number will be held until the customer is contacted. This will result in delays in servicing HVPS/SC.

If returning HVPS/SC with a crystal sensor or another component potentially exposed to process materials, prior to being given an RMA number, a completed Declaration Of Contamination (DOC) form will be required. DOC forms must be approved by INFICON before an RMA number is issued. INFICON may require that the component be sent to a designated decontamination facility, not to the factory.

PN 074-611-P1B

## 1.4 HVPS/SC Specifications

All specifications are at full power unless otherwise noted.

### 1.4.1 Filament Specifications

| | |
|---|---|
| Filament Current Operational Modes | Off (HV only), Filament Current (FC Only), Emission Current (Normal) |
| Maximum Filament Current | 20 to 70 A |
| Filament Current Setpoint | 0 to 70 A (applicable only in FC Only Mode) |
| Maximum Emission Current | 10 to 999 mA |
| Environmental Efficiency[1] | >90% (at 10 kV, 1 A output) |
| Power Factor | >0.9 |
| Economic Efficiency[2] | ≥90% |
| Minimum Arc Recovery Time[3] | 15 to 1000 ms total recovery |
| Maximum Stored Energy[4] | <2 J |
| Output Ripple + Regulation | <5% RMS |
| Output Setpoint Accuracy | <1% of reading or 50 V whichever is higher |

[1,2,3,4] See Appendix A

### 1.4.2 General Specifications

| | |
|---|---|
| Cooling | Forced air, two internal fans |
| Short Circuit Protection | Yes |
| Overvoltage Protection | Yes |
| Overheating Protection | Yes |
| Front Panel | 240 x 64 backlit high-contrast, long-life LCD, seven status indicators, control knob, selection buttons |

PN 074-611-P1B

### 1.4.3 I/O Specifications

| | |
|---|---|
| Interface Input Rating | 5 to 36 V (ac) • V (dc) isolated or grounded<br>non-isolated, contact closure |
| Digital Input Functions | Door/Safety AUX Interlock<br>Remote/Local Mode<br>Remote On<br>Vacuum and Water Interlocks |
| Filament Output | High voltage cable |
| Analog Input | 0 to -10 V emission current control |
| Analog Outputs (2) | 0 to 10 V indicating 0 to 1000 mA<br>0 to 10 V indicating 0 to 10000 V |
| Relay Rating | SPST, 30 V (dc) • V (rms), 2 A |
| Digital Output Functions | High Voltage On<br>High Voltage Ready |
| Communications | USB, RS-232/RS-485 |

### 1.4.4 Power Specifications

| | |
|---|---|
| Input Power (phase to phase) | Low Line Configuration<br>208 V (ac), 3 Φ, 40 A, 50/60 Hz, ±10%<br>High Line Configuration<br>400 V (ac), 3 Φ, 25 A, 50 Hz, ±5%<br><br>**NOTE:** Do not exceed<br>400 V (ac) input power |
| Output Voltage | -4 to -10 kV incremented by 50 volt intervals |
| Output Current Range | 10 to 999 mA |
| Output Power | 0 to 10 kW |

### 1.4.5 Operating Environment

| | |
|---|---|
| Operating Temperature | 5 to 30°C |
| Maximum Operational Altitude | 2000 m above mean sea level |
| Humidity Range | 20 to 80%, non-condensing |
| Storage Temperature Range | -30 to 40°C |
| Transport Temperature Range | -30 to 50°C |

PN 074-611-P1B

### 1.4.6 Size

Size . . . . . 133.4 x 434.3 x 436.9 mm
(5.25 x 17.1 x 17.2 in.)

### 1.4.7 Weight

Weight . . . . . 22.9 kg (50.5 lb.)

## 1.5 Unpacking and Inspection

1. If HVPS/SC has not been removed from its packaging, do so now.
2. Carefully examine the contents for damage that may have occurred during shipping. This is especially important if obvious rough handling is noticed on the outside of the container. *Immediately report any damage to the carrier and to INFICON.*
3. Do not discard the packing materials until inventory has been taken and installation has been performed successfully.
4. Take an inventory of the order by referring to the order invoice.
5. To install HVPS/SC, see Chapter 2, Installation.
6. For additional information or technical assistance, refer to section 1.3, How To Contact INFICON, on page 1-4.

## 1.6 Configurations

PN HVPS/SC-208 . . . . . HVPS/SC e-Beam Deposition Power Supply
Low Mains Voltage, 200 to 240 V (ac)

PN HVPS/SC-400 . . . . . HVPS/SC e-Beam Deposition Power Supply
High Mains Voltage, 380 to 400 V (ac)

### 1.6.1 Accessories

The following accessories are included in the HVPS/SC ship kit:

Thin Film Instrument and
Sensor Manuals CD . . . . . PN 074-5000-G1

Rack Mount Supports . . . . . PN 783-014-072-P1

Hand Controller . . . . . PN 783-500-198-G1

RS-232 Cable . . . . . PN 783-506-000-P1

PN 074-611-P1B

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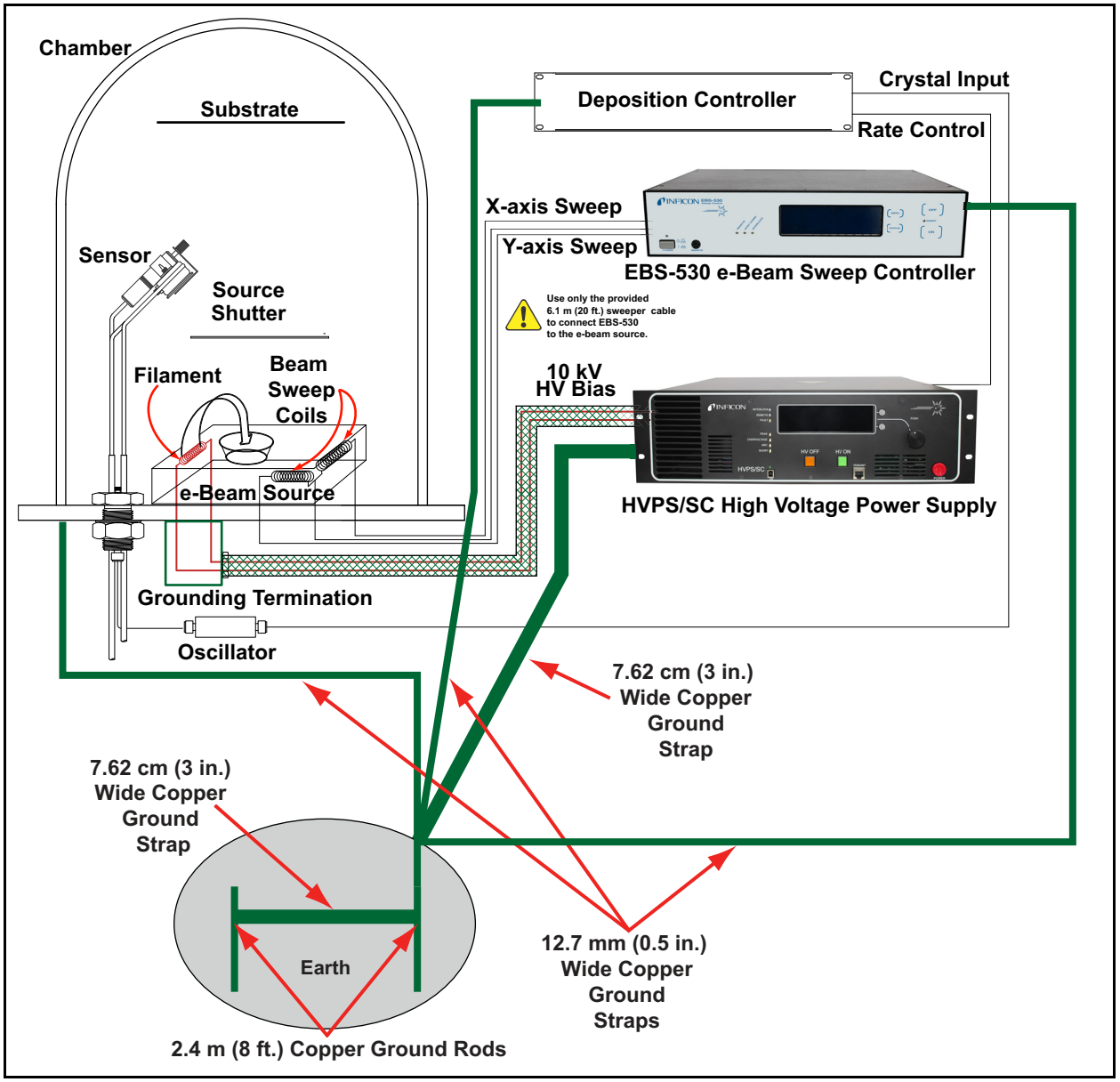
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# Chapter 2
# Installation

## 2.1 Properly Grounding the e-Beam Vacuum Deposition System

See Figure 2-1 for a diagram of a properly grounded electron beam vacuum deposition system.

*Figure 2-1 Grounding diagram*




PN 074-611-P1B

### 2.1.1 Grounding Requirements

All system components must be properly grounded. (Refer to Figure 2-1.)

- Each instrument case in the control rack must be connected by a separate, dedicated ground strap to a common local ground (a *star* configuration).

  **NOTE:** Do not use braided wire. Use a solid copper strap.

- The green (or green with yellow tracer) wire on the HVPS AC power input cable must be connected to the branch circuit ground. (See section 2.1.3 on page 2-5.)

Low impedance cables or straps must be used to connect the cases of all control components to a common ground point on the vacuum chamber. The common ground point must be connected to earth ground. (See section 2.1.2 for the earth ground requirement.)

Use a strap of the shortest possible length, with a minimum width of 76 mm (3 in.) and approximately 0.9 to 1.3 mm (0.04 to 0.05 in.) thick.

**NOTE:** Do not use braided wire. Use a solid copper strap.

**NOTE:** The oscillator is grounded to the deposition controller and crystal sensor through the BNC cables.

The crystal sensor is grounded to the wall of the vacuum system. Additionally, connect a copper strap between the crystal sensor feedthrough and the common ground point on the vacuum system.



**WARNING - Risk Of Electric Shock**

**Ground strain-relief on the high voltage cable *must be installed to a grounding termination* in vacuum deposition system.**

PN 074-611-P1B

## 2.1.2 Establishing Earth Ground



**WARNING - Risk Of Electric Shock**

**Follow local electrical regulations and codes.**

1. Install two 3 m (10 ft.) long copper-clad steel ground rods into the soil, spaced at least 1.9 m (6.2 ft.) apart. The ideal distance between the rods is 6.1 m (20 ft.) (twice the rod length).
2. Pour a solution of magnesium sulfate or copper sulfate around each rod to reduce resistance to earth ground.
3. Test the ground rods using a ground resistance tester specifically designed for that purpose.

   **NOTE:** Do not use a common ohmmeter.
4. After verifying that a good earth ground has been achieved, connect the rods together with a solid copper strap. Use a strap of the shortest possible length, with a minimum width of 76 mm (3 in.) and approximately 0.9 to 1.3 mm (0.04 to 0.05 in.) thick.

   **NOTE:** Do not use braided wire. Use a solid copper strap.

PN 074-611-P1B

#### 2.1.2.1 Alternative Earth Ground

Grounded structural steel of the building may be used as an earth ground if HVPS/SC is to be installed in an area without access to the twin rods installed in section 2.1.2.



**WARNING - Risk Of Electric Shock**

**Follow local electrical regulations and codes.**

1. Bolt a solid copper strap to clean, bare, grounded structural steel of the building. Use a strap of the shortest possible length, with a minimum width of 76 mm (3 in.) and approximately 0.9 to 1.3 mm (0.04 to 0.05 in.) thick.

   **NOTE:** Do not use braided wire. Use a solid copper strap.

2. Test the grounded structural steel using a ground resistance tester specifically designed for that purpose.

   **NOTE:** Do not use a common ohmmeter.

3. After verifying that a good earth ground has been achieved, connect the copper strap to the common local ground.

   **NOTE:** Do not use water pipes to establish a ground connection.

PN 074-611-P1B

## 2.1.3 Electric Power Mains Connection

**WARNING - Risk Of Electric Shock**

**Dangerous voltages are present at electric power mains which could result in personal injury.**

HVPS/SC is provided with 3-phase (three wires plus ground; no neutral connection) AC power for a dedicated branch circuit.

While phase sequence is not important, *the green (or green with yellow tracer) wire must be connected to the branch circuit ground.*

- The AC power circuit must be rated for a minimum of:
  - 40 A for a 208 V (ac) low-line configuration
  - 25 A for a 400 V (ac) high-line configuration
- The AC power circuit must be terminated by an auxiliary distribution panel mounted within 1.2 m (4 ft.) of the HVPS/SC rear panel.
  - The auxiliary distribution panel must be visible and accessible to the HVPS/SC operator.
  - The auxiliary distribution panel must include a clearly marked, easily accessible, power mains switch that meets the requirements of IEC 60947-1 and IEC 60947-3.
  - The auxiliary distribution panel must include a primary circuit breaker which meets the requirements of IEC 60947-2 and/or UL489, and is rated:
    - 40 A for a 208 V (ac) low-line configuration
    - 25 A for a 400 V (ac) high-line configuration

A circuit breaker may perform the function of a power mains switch provided that it is accessible, clearly marked, and rated for use as a disconnect device. The disconnect device and/or circuit breaker must be installed by a qualified electrician in accordance with local codes.

**CAUTION**

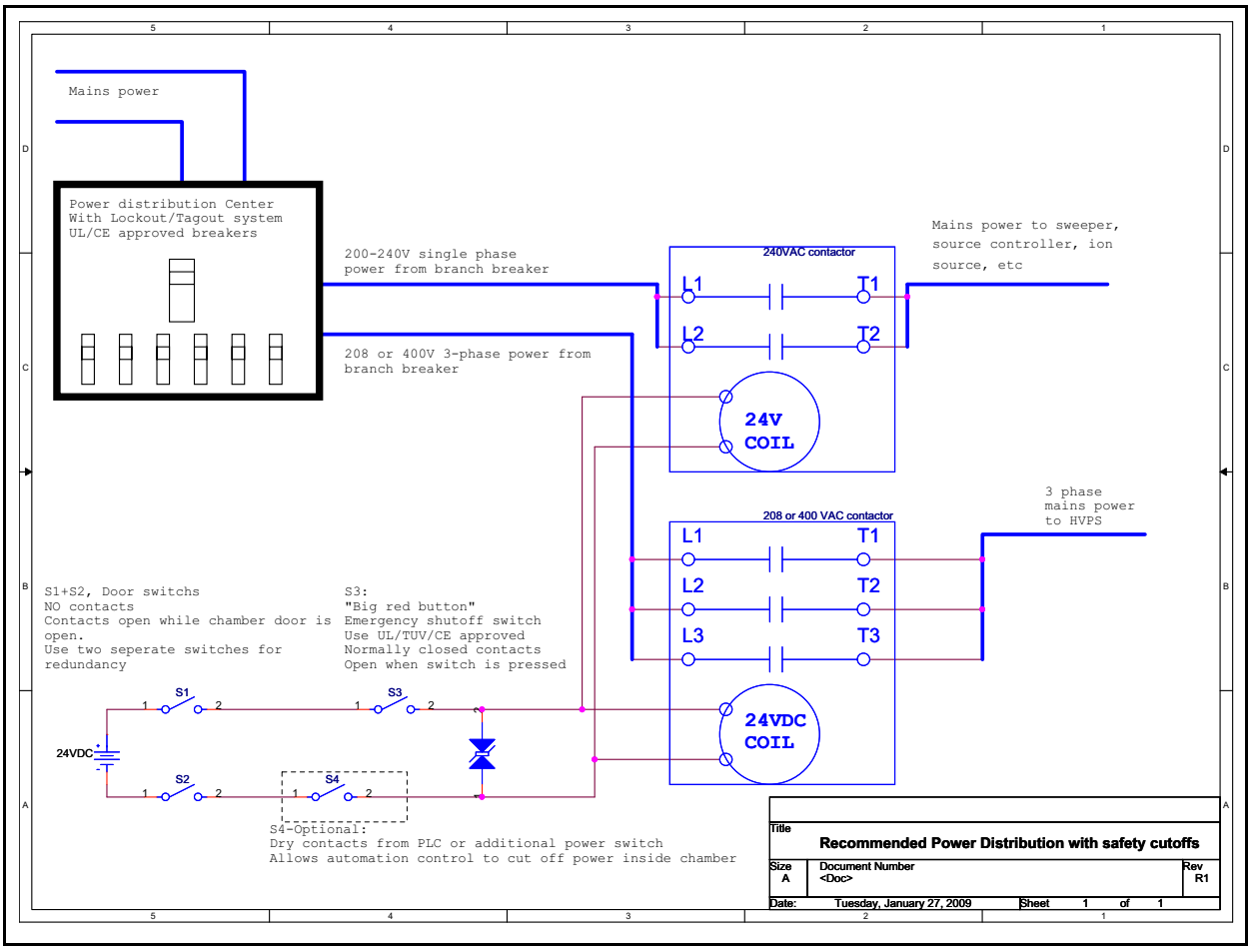
**If an alternate configuration is required, return HVPS/SC to INFICON for conversion. There are no user-serviceable components within the HVPS/SC case.**

The AC power system must have an emergency AC power disconnect switch.

PN 074-611-P1B

The auxiliary distribution panel must have a door interlock switch installed such that all AC power is removed from the HVPS/SC system when the distribution panel door is opened. (See Figure 2-2.)

*Figure 2-2 Power distribution diagram*




PN 074-611-P1B

## 2.2 Safety

### 2.2.1 Lockout/Tagout Procedure



**WARNING - Risk Of Electric Shock**

**Follow local electrical regulations and codes.**

Proper lockout/tagout practices and procedures safeguard workers from the release of hazardous energy. The HVPS/SC AC power disconnect switch must be locked out in accordance with local lockout/tagout regulations.

Before starting any maintenance and repair, secure the HVPS/SC electrical distribution panel AC power OFF with a padlock and affix a lockout tag to the distribution panel which prevents the panel from being opened.

### 2.2.2 Opening the Chamber

HVPS/SC automatically discharges dangerous voltages within a few seconds after AC power is removed. However, if electric power is removed when HVPS/SC is in an error condition, a charge may remain stored on the filament. (See section 5.2.4, Error Messages, on page 5-5.)



**WARNING**

**Work with a partner while installing or removing any component of the vacuum system, including the high voltage power supply. Do not work alone.**



**WARNING - Risk Of Electric Shock**

**Dangerous voltages are present which could result in personal injury.**



**WARNING - Risk Of Electric Shock**

**When the chamber is opened, a grounding rod must be used to discharge voltage at the leads connecting to the filament and to discharge any energy stored in the components of the chamber.**

PN 074-611-P1B

**WARNING - Risk Of Electric Shock**

**Immediately after using the grounding rod, clip a grounding wire onto the lead to the filament supply bus bar or dedicated electrode to secure connection to ground while the chamber door is open.**

1. Set the AC power disconnect switch OFF and lockout/tagout as instructed in section 2.2 on page 2-7.
2. Wait at least ten minutes.
3. Open the chamber and use the grounding rod to discharge the filament by touching the grounding rod to the filament supply bus bar or dedicated electrode.
4. After discharging the filament, clip the grounding lead to the filament supply bus bar or dedicated electrode.

### 2.2.3 Installation and Maintenance Safety

**CAUTION**

**Follow all local safety rules during maintenance or repair.**

**WARNING - Risk Of Electric Shock**

**Set the AC power disconnect switch OFF and lockout/tagout as instructed in section 2.2 on page 2-7.**

**WARNING - Risk Of Electric Shock**

**Wait a minimum of ten minutes after mains power is disconnected before attempting any maintenance or repair.**

**WARNING - Risk Of Electric Shock**

**Do not allow any energized components or connections to be exposed during normal HVPS/SC operation.**

PN 074-611-P1B

**WARNING - Risk Of Electric Shock**

**Post high voltage warning signs conspicuously in the operating area where connections are made and wherever cables are present.**

**WARNING - Risk Of Electric Shock**

**Restrict access to dangerous areas, such as feedthroughs to the vacuum chamber and the rear of the equipment rack.**

**WARNING - Risk Of Electric Shock**

**Place a fence or railing around the rear of the chamber to prevent access to feedthrough connections.**

**CAUTION**

**Do not leave feedthrough connections exposed.**

## 2.3 Mounting

Follow all of the cautions and warnings in section 1.2, Safety, on page 1-2 and in section 2.2, Safety, on page 2-7.

**WARNING - Risk Of Electric Shock**

**Set the AC power disconnect switch OFF and lockout/tagout as instructed in section 2.2 on page 2-7.**

Install HVPS/SC on a rack with rear mounting rails to provide adequate support.

1. Install one rear mount support on a rack with rear mounting rails using two #10 or larger machine screws and one of the rear mount supports.
2. Align the predrilled holes on one rear mount support with the predrilled holes on the rear mounting rail of the rack.
3. Insert one #10 or larger machine screw into each of the two holes once aligned.

PN 074-611-P1B

**4** Tighten the screws. (See Figure 2-3.)

*Figure 2-3 Rear mount support*



**5** Install the second rear mount support using two #10 or larger machine screws and the remaining rear mount support.

**6** Align the predrilled holes on the second rear mount support with the predrilled holes on the rear mounting rail of the rack.

**7** Insert one #10 or larger machine screw into each of the two holes once aligned.

**8** Tighten the screws. (See Figure 2-4.)

*Figure 2-4 Rear mount support*



**9** Mount HVPS/SC in a sturdy equipment rack by sliding HVPS/SC into an empty 3U rack-mount space (133.4 x 482.6 mm [5.25 x 19.0 in.]) on top of the installed rear mount supports.

**10** Have one or two people hold HVPS/SC in place.

**11** Align the predrilled holes on the HVPS/SC chassis with the predrilled holes on the front mounting rails of the rack.

**12** Insert one #10 or larger machine screw into each of the four holes once aligned.

PN 074-611-P1B

**13** Tighten the screws. (See Figure 2-5.)

*Figure 2-5 HVPS/SC mounted*




**14** Provide space behind and in front of HVPS/SC for sufficient airflow.

**NOTE:** Do not block the front air intake or the rear fan exhaust.

**15** Install a supplemental safety ground between HVPS/SC and the chamber. (Refer to section 2.1.1 on page 2-2.)

**16** Install the power cord directly into the auxiliary distribution panel. (Refer to section 2.1.3 on page 2-5.)

**NOTE:** The use of a plug is not allowed.

**17** Connect the high voltage power cable to filament leads and grounding termination. (See section 2.5.5 on page 2-18.)

**CAUTION**

**To maintain proper HVPS/SC performance, use only the provided 3.65 m (12 ft.) high voltage power cable to connect HVPS/SC to the filament high voltage feedthroughs.**

**NOTE:** If a longer or shorter length cable is required, contact INFICON. (Refer to section 1.3 on page 1-4.)

**WARNING - Risk Of Electric Shock**

***Do not lengthen or shorten the cable.*** **This will cause personal injury, damage to HVPS/SC, and affect performance. The high voltage power cable *must* be maintained as provided by INFICON or the warranty will be void.**

**Filament lead connections must be a minimum of 2.54 cm (1 in.) from all grounded surfaces.**

**18** Connect the digital I/O cable, source control cable, and the network cable. (See section 2.5 on page 2-13.)

## 2.4 Removal



**WARNING - Risk Of Electric Shock**

**Dangerous voltages are present.**



**WARNING - Risk Of Electric Shock**

**Set the electric power mains switch OFF and lockout/tagout as instructed in section 2.2 on page 2-7.**



**CAUTION - Static Sensitive Device**

**HVPS/SC contains circuitry susceptible to transient power line voltages. Disconnect the high voltage power cable whenever making or removing any interface connections.**

1. Disconnect the digital I/O cables, source control cable, and the network cable. (See section 2.5 on page 2-13.)
2. Remove the power cord from the auxiliary distribution panel.
3. Remove the high voltage power cable from the fully enclosed grounding termination and from the filament leads. (See section 2.5.5 on page 2-18.)
4. With one or two people holding the supply in place, remove the four screws on the front panel from the equipment rack.



**CAUTION**

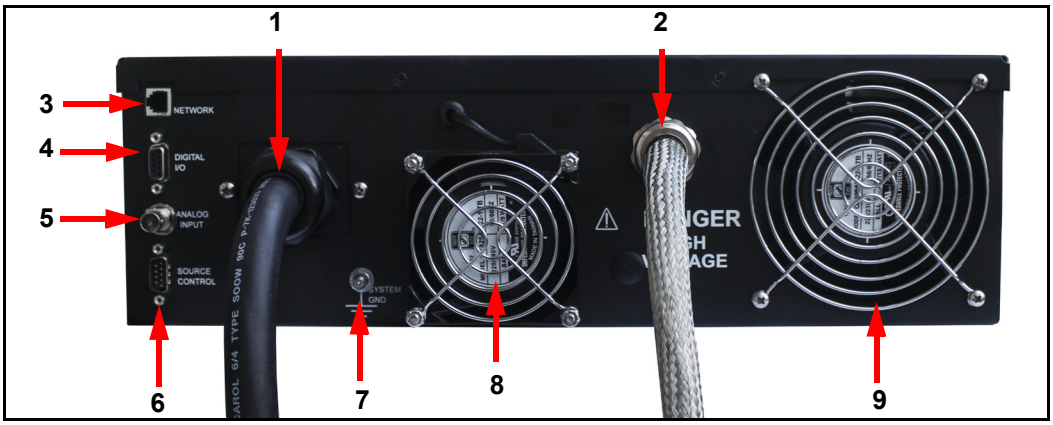
**Make sure HVPS/SC is properly supported while the mounting screws are being removed.**

5. Remove HVPS/SC from the equipment rack.
6. Remove rear mount supports from the rack by removing the two machine screws from each rear mount support.

PN 074-611-P1B

## 2.5 Rear Panel Description

*Figure 2-6 Rear panel connections*




**CAUTION**

**Connecting cables must be routed away from any potential source of electrical noise.**

***1*** **AC Power Inlet**

Provides a 3-phase, delta-connected (three wires plus ground; no neutral connection) AC power for a dedicated branch circuit. (Refer to section 2.1.3 on page 2-5.)

***2*** **High Voltage Power Cable**

3.65 m (12 ft.) high voltage power cable connecting HVPS/SC to the filament high voltage feedthroughs.

***3*** **Network Connection**

Provides the RS-232 or RS-485 interface standard for communication. (See section 2.5.1.)

***4*** **Digital I/O Connection**

Provides a 9-pin female D-type connector for Remote/Local mode, High Voltage (HV) Ready, isolated 5V I/O HV On, and AUX/Door Interlock. (See section 2.5.2.)

***5*** **Analog Input Connection**

Provides 0 to -10.0 V analog input for interfacing with a deposition controller. (See section 2.5.3 on page 2-16.)

***6*** **Source Control Connection**

9-pin male D-type connector for water and vacuum interlocks, Turn On input, emissions current monitoring, and high voltage monitoring. (See section 2.5.4 on page 2-17.)

PN 074-611-P1B

***7*** **Ground Post**
Provides a grounding point to attach a solid copper strap to the common local ground. (Refer to section 2.1.1 on page 2-2.)

***8*** **Fan Outlet**
Provides exhaust opening for fan. *Do not block the fan outlet.*

***9*** **Fan Outlet**
Provides exhaust opening for fan. *Do not block the fan outlet.*

### *2.5.1 Network*

The network connection is for RS-232 or RS-485 communication using Sycon Multi-Drop Protocol (SMDP) software. The included RS-232 cable (PN 783-506-000-P1) is required to connect this port directly to an isolated or locally grounded laptop or computer.

**NOTE:** If a connection is made to any remotely grounded device during vacuum deposition operations, a means of isolation must be provided by the user.

**CAUTION**

**Not isolating the remotely grounded device during vacuum deposition risks data corruption and/or possible damage to either the remotely grounded device or HVPS/SC in the event of arcing within the vacuum chamber.**

Use an isolated RS-232 to USB converter when connecting to a remotely grounded device.

A laptop or computer must have SMDP software installed and configured. (See Chapter 4, Communications.)

PN 074-611-P1B

## 2.5.2 Digital I/O

HVPS/SC includes basic I/O capabilities through a 9-pin female D-type connector. (See Figure 2-7 for a pinout diagram and Table 2-1 for pin numbers.)

*Figure 2-7 Digital I/O pinout*

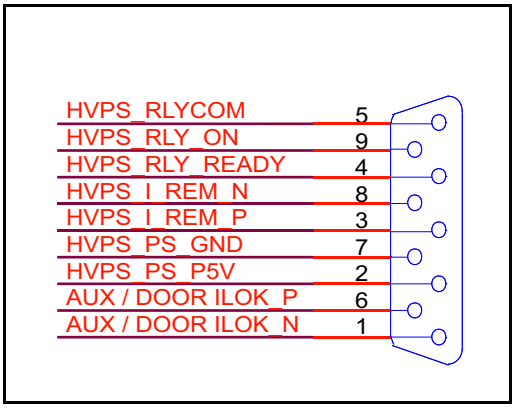



*Table 2-1 Digital I/O pin numbers*

| Pin# | Pin Name | Description |
|---|---|---|
| 1 | AUX/DOOR ILOK_N | Negative AUX / Door Interlock input. |
| 2 | HVPS_PS_P5V | Positive pin for 5 V internal supply used to drive inputs. |
| 3 | HVPS_I_REM_P | Positive Remote Mode input accepting 5 to 24 V (dc). |
| 4 | HVPS_RLY_READY | HV Ready output. Conducts to pin 5, HVPS_RLYCOM when high voltage supply is ready, all interlocks satisfied, and no error conditions present. HVPS/SC can generate HV if requested. |
| 5 | HVPS_RLYCOM | Common pin for HV Ready and HV On output, Pin 4 and Pin 9. |
| 6 | AUX/DOOR ILOK_P | Positive AUX/Door Interlock input accepting 5 to 24 V (dc). |
| 7 | HVPS_PS_GND | Negative pin for 5 V internal supply used to drive inputs. |
| 8 | HVPS_I_REM_N | Negative Remote Mode input. |
| 9 | HVPS_RLY_ON | HV On output. Conducts to pin 5, HVPS_RLYCOM when high voltage supply is on (generating High Voltage output). |

### 2.5.2.1 Relay Outputs

HVPS/SC has two floating relay contact outputs. (See Table 2-2.) Pin 4 corresponds to HV Ready and Pin 9 corresponds to HV On. Pin 5 is the common pin for both relays.

Contact closure for each of the relays will indicate HV is On (pin 9 to 5) or Ready (pin 4 to 5).

*Table 2-2 Relay outputs*

| Relay Number | Description | Pin Numbers |
|---|---|---|
| 1 | HV Ready | 4, 5 |
| 2 | HV On | 9, 5 |

#### 2.5.2.2 Digital Inputs

HVPS/SC has two optically isolated inputs. (See Table 2-3.)

- an AUX/Door interlock
- an input to place HVPS/SC in remote mode

Driving each of these optically isolated inputs with a 5 to 24 V (dc) signal will satisfy the interlock and select remote mode, respectively (independently).

**NOTE:** An isolated 5 V (dc) supply can be shared with the source control connection to provide this voltage signal, if needed. (See section 2.5.4.)

*Table 2-3 Digital inputs*

| Input Number | Description | Pin Numbers (Pos, Neg respectively) |
|---|---|---|
| 1 | AUX/Door Interlock | 6, 1 |
| 2 | Remote Mode | 3, 8 |

### 2.5.3 Analog Input

The Analog Input provides control to the emission current of HVPS/SC during an e-beam deposition. The Analog Input connection accepts a non-isolated 0 to -10.0 V control signal.

The BNC connection is grounded at its shell, and the center female pin is driven negative by a signal supplied from a thin film deposition controller.

Analog Input has a full scale range of 0 to -10 V and is scaled to represent 0 to the Maximum Emission of HVPS/SC, as programmed on the Operational Settings screen. (See section 3.6.1 on page 3-10.)

**CAUTION**

**Do not edit the maximum emission current with high voltage enabled. Large disturbances in the emission power may be produced.**

PN 074-611-P1B

## 2.5.4 Source Control

The Source Control connection provides inputs for water and vacuum interlocks and high voltage on and off status and requests.

Driving these optically isolated inputs with a 5 to 24 V (dc) signal will satisfy the interlocks and allow HVPS/SC to enable high voltage.

**NOTE:** A single, common isolated 5 V (dc) supply (pins 3 and 4) shared with the Digital I/O connection can provide this voltage signal, if needed. (Refer to section 2.5.2.)

For high voltage to be enabled, Turn On must be active, all interlocks must be satisfied, and there must be no errors.

*Figure 2-8 Source Control pinout*

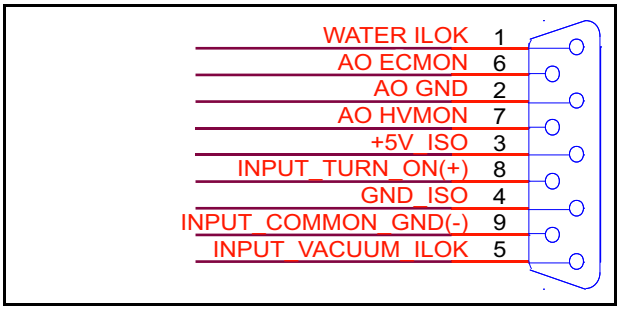



*Table 2-4 Source Control pin numbers*

| Pin | Pin Name | Description |
|---|---|---|
| 1 | WATER ILOK OK | Positive Interlock input accepting 5 to 24 V (dc). |
| 2 | AO GND | Common pin for analog output emission current and high voltage, pin 6 and pin 7. |
| 3 | +5V_ISO | Positive pin for 5 V internal supply used to drive inputs<br>**NOTE:** Common supply shared with Digital I/O interface female DB9 pin. |
| 4 | GND ISO | Negative pin for 5 V internal supply used to drive inputs. (Note: common supply shared with Digital I/O interface female DB9 pins 2 and 7) |
| 5 | INPUT_VACUUM_ILOK | Positive Vacuum input accepting 5 to 24 V (dc), relative to pin 9 input common negative. |
| 6 | AO ECMON | Analog output with a full scale range of 0 to +10.0 volts scaled to represent 0 to 1000 mA emission current. |
| 7 | AO HVMON | Analog output with a full scale range of 0 to +10.0 volts scaled to represent 0 to 10000 V high voltage. |
| 8 | INPUT_TURN_ON(+) | Positive Turn On input accepting 5 to 24 V (dc), relative to pin 9 input common negative. |
| 9 | INPUT_COMMON_GND(-) | Common pin for Turn On and interlock inputs, Pins 8, 1, and 5. |

PN 074-611-P1B

### 2.5.5 High Voltage Power Cable Connection

**CAUTION**

**To maintain proper HVPS/SC performance, use only the provided 3.65 m (12 ft.) high voltage power cable to connect HVPS/SC to the filament high voltage feedthroughs.**

**NOTE:** If a longer or shorter length cable is required, contact INFICON. (Refer to section 1.3 on page 1-4.)

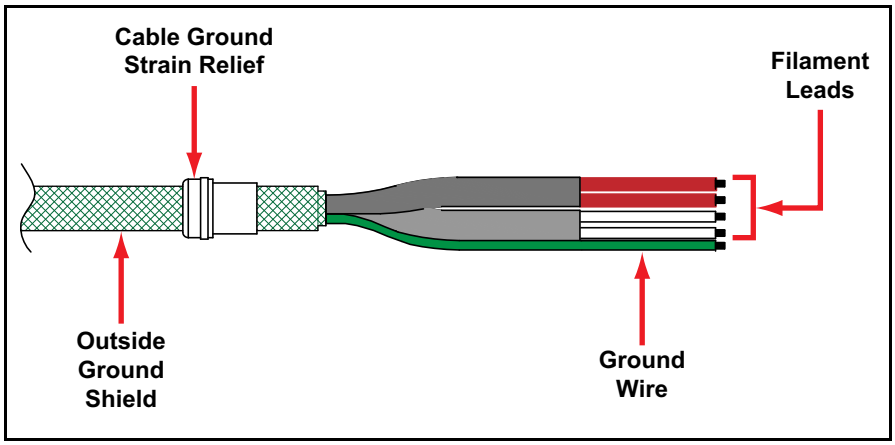
**WARNING - Risk Of Electric Shock**

***Do not lengthen or shorten the cable.*** **This will cause personal injury, damage to HVPS/SC, and affect performance. The high voltage power cable *must* be maintained as provided by INFICON or the warranty will be void.**

**Ground strain-relief on the high voltage power cable *must be installed to a grounding termination* in vacuum deposition system.**

HVPS/SC is manufactured with a high voltage power cable that has two pairs of high voltage wires, separated by color and shrink wrap, and a ground strain-relief connection attached to the outer shield of the cable. (See Figure 2-9.)

*Figure 2-9 High voltage power cable*




The filament leads must be connected to the filament and surrounded by a fully enclosed grounding termination. (See Figure 2-10.)

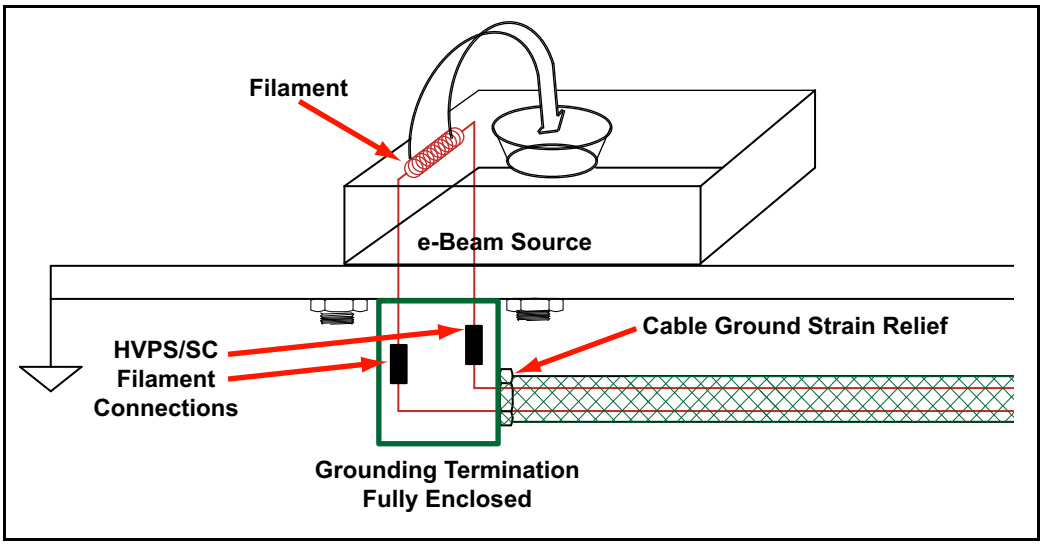
The **green** ground wire must be connected to the common ground point on the vacuum system. (Refer to section 2.1.1 on page 2-2.)

PN 074-611-P1B

## WARNING - Risk Of Electric Shock

**Filament lead connections must be a minimum of 2.54 cm (1 in.) from all grounded surfaces.**

*Figure 2-10 Filament connection*




- The fully enclosed grounding termination must be:
  - Securely attached (or bolted) and grounded to the chamber.
  - Able to connect to the cable ground strain-relief.
- The filament connections must be grounded prior to making interface connections to the HVPS/SC rear panel.
  - Grounding clips can be attached to the e-beam gun inside the chamber and the system grounded with a grounding rod.
  - Grounding clips can be attached directly to the filament connections and grounded with a grounding rod.

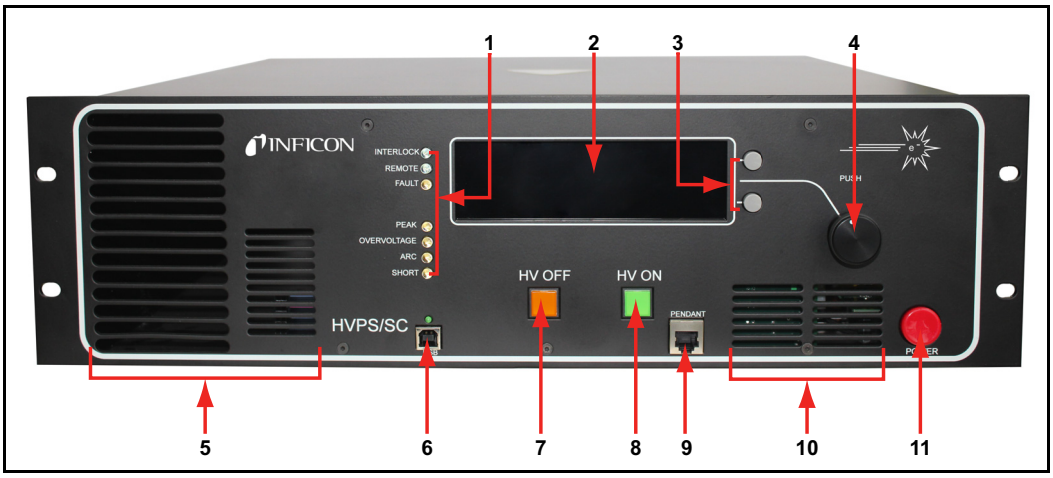
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PN 074-611-P1B

# Chapter 3
# Operation

## 3.1 Front Panel Description

*Figure 3-1 HVPS/SC front panel*




**1 Status Indicators**

Provides status of interlocks, remote mode, errors, and safety. (See section 3.1.1.)

**2 Display**

Displays programming functions and information. Alternate screens are displayed in response to programmed selections. (See section 3.3 on page 3-4.)

**3 Selection Buttons**

Press to select the function on the display aligned with the button. Alternate functions are displayed in response to programmed selections.

**4 Control Knob**

Rotates to scroll up or down menu list items, scroll through fixed choices, and increase or decrease value-based parameters. Press to select the function on the display that is aligned with the control knob.

**5 Air Intake Vents**

Cooling air intake openings. *Do not block the air intake openings.*

**6 USB Connection**

Provides connection for remote communication through the USB interface. (See section 3.1.2.)

PN 074-611-P1B

**7 HV OFF**

Press to turn off high voltage output.

**8 HV ON**

Press to turn on high voltage output (if HVPS/SC is in local mode).

**NOTE:** All interlocks must be satisfied to turn on high voltage output.

**9 Pendant**

Provides connection to INFICON hand controller, PN 783-500-198-G1.

**10 Air Intake Vents**

Cooling air intake openings. *Do not block the air intake openings.*

**11 Power Button**

When depressed, AC power is supplied to HVPS/SC.

**WARNING - Risk Of Electric Shock**

**High voltage could result from this action if the digital I/O and interlocks request the HVPS/SC to supply HV. Proper use of interlocks must be followed to ensure operator safety.**

### 3.1.1 Front Panel Indicator Descriptions

See Table 3-1 for a description of the indicators on the front panel.

*Table 3-1 Front panel indicator descriptions*

| Indicator | Description |
|---|---|
| **Interlock** | When illuminated, all interlocks are satisfied; HV will enable. When extinguished, one or more interlocks are unsatisfied; HV will not enable. Unsatisfied interlocks are identified on the lower line of the display. (See Figure 3-2 on page 3-5.) VAC, WATER, and DOOR are external I/O connections. COVER is an internal switch that detects HVPS/SC cover removal.<br>**NOTE:** High voltage will not engage when the cover is removed.<br>**WARNING - Risk Of Electric Shock**<br>**There are dangerous voltages present inside the case from input mains power.** |
| **Remote** | HVPS/SC is controlled remotely. (See section 3.2.) |

PN 074-611-P1B

*Table 3-1 Front panel indicator descriptions (continued)*

| | |
|---|---|
| **Fault** | HVPS/SC detected an internal error and HV is disabled. An error message is displayed. (See section 5.2.4 on page 5-5.) |
| **Peak** | HVPS/SC is delivering full power. This may occur when incoming power line voltage is low. |
| **Overvoltage** | Output exceeds 11.2 kV. HV disables briefly and then is enabled. If this occurs three times in a row, HVPS/SC will power off. |
| **Arc** | HVPS/SC detected an arc and HV disabled for the programmed arc delay time and then is enabled. |
| **Short** | HVPS/SC detected a short. HV disables briefly and then is enabled. If this occurs three times in a row, HVPS/SC will power off. |

### 3.1.2 USB Connection

The USB interface port follows USB 2.0 protocol using INFICON drivers. This interface is not isolated and is intended for connection to an isolated or locally grounded computer. Use a USB to USB isolator for connection to a remotely grounded device.

**CAUTION**

**A means of isolation must be provided by the user when HVPS/SC is connected to a remotely grounded device during vacuum deposition operations.**

**Not providing isolation risks data corruption and/or possible damage to either the remotely grounded device or HVPS/SC in the event of arcing within the vacuum chamber.**

See Chapter 4, Communications for information about USB drivers and SMDP software installation and configuration.

## 3.2 Local and Remote Mode

HVPS/SC is operated in either Remote mode or Local mode.

- In Remote mode, press **OFF** (**STOP** on the handheld controller) to place HVPS/SC in **ABORT**. To exit **ABORT**,
  - press **ON** (press **OFF** twice)
  - return to Local mode by removing the I/O REMOTE assertion request

  **NOTE:** A removal/reassertion of REMOTE request will return to Remote NORMAL mode in the same way as pressing **ON**.

PN 074-611-P1B

- In Local mode, on/off requests by the Digital I/O interface are ignored. High voltage is turned on by pressing **HV ON** and turned off by pressing **HV OFF** (**STOP** on the handheld controller).

  **NOTE:** Pressing **Power** will also turn off high voltage and/or filament current and power down HVPS/SC.

**WARNING**

**If interlocks are not satisfied when HV ON is pressed, HVPS/SC will generate HV as soon as interlocks are established.**

**Press HV OFF to disable the request for high voltage.**

## 3.3 Operation

Before operating HVPS/SC, read and understand section 1.2, Safety, on page 1-2. Install HVPS/SC as instructed in Chapter 2, Installation.

**WARNING - Risk Of Electric Shock**

**Dangerous voltages are present which could result in personal injury.**

**WARNING**

**If HVPS/SC is used in a manner not specified by INFICON, the protection provided by it may be impaired.**

1. Press **Power** (refer to Figure 3-1 on page 3-1) to turn HVPS/SC on. When startup has completed, the **Runtime** screen will display. (See section 3.4.)
2. Press **HV ON** to enable high voltage. **HV ON** will illuminate in **green**.

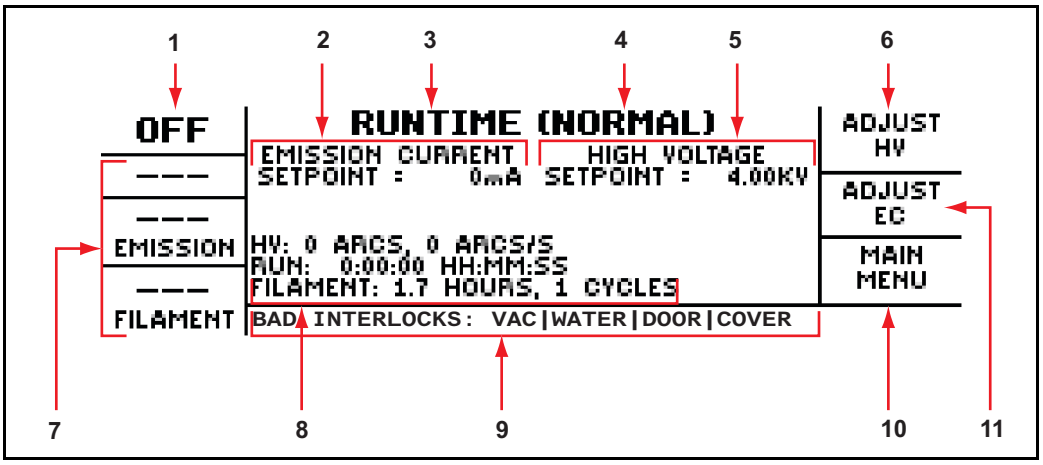
   **NOTE:** If interlocks are unsatisfied, **Interlock** will be extinguished and the **HV ON** button will be disabled.
3. Press **HV OFF** to disable high voltage and/or filament current . **HV OFF** will illuminate in **orange**.

PN 074-611-P1B

## 3.4 Runtime Screen

The **Runtime** screen provides information about programmed and recorded parameters. (See Figure 3-2.) This includes the setpoints, operational setting, and statistics. The **Runtime** screen displays **OFF** when the HVPS/SC high voltage or filament current is disabled.

*Figure 3-2 Runtime screen*




### *1* HV Status

Status (or condition) of the power supply.

**ON** . . . . . Enabled high voltage and/or filament current.

**OFF** . . . . . Disabled high voltage and/or filament current.

**STBY** . . . . . HVPS/SC in standby. High voltage and/or filament current will enable when interlocks are satisfied.

**ABRT** . . . . . HVPS/SC was in Remote mode and turned off by the front panel **HV OFF** button or the hand controller **STOP** button. Press **HV ON** to enable high voltage and/or filament current.

**ERR** . . . . . See section 5.2.4 on page 5-5 for information about error messages. Press **HV ON** to enable high voltage and/or filament current.

PN 074-611-P1B

**2 Emission Current Setpoint**

HVPS/SC controls the filament current as needed to output programmed emission current. (See section 3.5.2 on page 3-8 for programming information.)

**NOTE:** Emission Current Setpoint is only available in Local mode. In Remote mode, emission current is controlled by the analog input connection on the rear panel.

**3 Screen Name**

Displays the name of the current screen.

**4 Operational Mode**

Displays operational mode currently programmed: normal, FC only, HV only.

**5 High Voltage Setpoint**

HVPS/SC will output programmed voltage when enabled. (See section 3.5.1 on page 3-7 for programming information.)

**6 Adjust HV**

Press the top selection button on the front panel (refer to Figure 3-1 on page 3-1) to edit the output voltage. (See section 3.5.1.)

**7 Active Indicators**

Displays active voltage, emission, and filament current values as they are measured. When HV and/or FC is OFF, dashes are displayed in place of measurements.

**8 Statistics and Message Area**

Displays statistics when no errors or special conditions exist.

- Total number of HV runtime (h:mm:ss)
- Total number of arcs

Displays diagnostic information, error message, or help message upon error. (See section 5.2.4 on page 5-5.)

**9 Interlock Status**

Displays the name of the interlock (Vac, Water, Door, or Cover) that is not satisfied. (See section 5.2.3 on page 5-4.)

**10 Main Menu**

Press the bottom selection button on the front panel (refer to Figure 3-1 on page 3-1) to access the **Main Menu** screen (see section 3.6 on page 3-9).

**11 Adjust EC**

Press the control knob on the front panel (refer to Figure 3-1 on page 3-1) to edit the emission current setpoint. (See section 3.5.2.)

PN 074-611-P1B

## 3.5 Editing Output Voltage and Emission Current Values

Output voltage and emission current values can be edited with the control knob or hand controller from the **Runtime** screen (**ADJUST HV** or **ADJUST EC**).

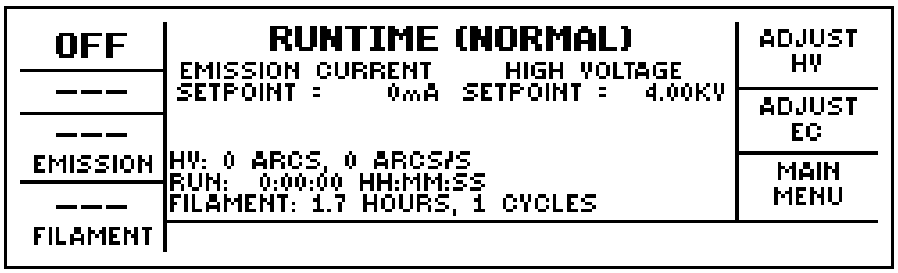
All other parameters are edited through the **Main Menu** screen. (See section 3.6 on page 3-9.)

### 3.5.1 Editing the Output Voltage

Output voltage can be edited using the control knob or the hand controller.

***1*** Display the **Runtime** screen. (See Figure 3-3.)

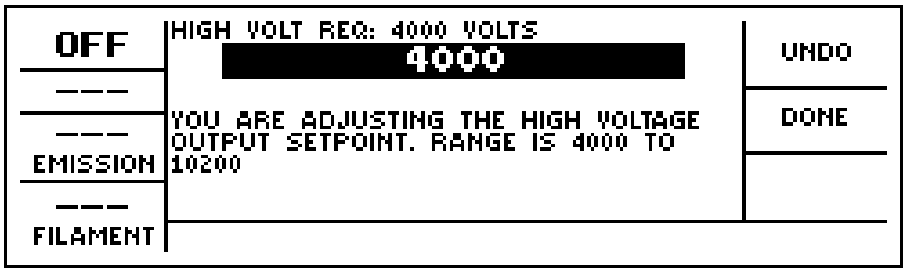
*Figure 3-3 Runtime screen top menu level*




***2*** Press the **ADJUST HV** selection button. The **Output Voltage Setpoint** screen is displayed. (See Figure 3-4.)

**NOTE:** Output voltage changes occur immediately.
The original value, before any changes were made, is displayed above the selected value.

*Figure 3-4 Output voltage setpoint adjustment screen*




PN 074-611-P1B

***3*** Increase or decrease the output voltage:

***3a*** Rotate the control knob counterclockwise to decrease or clockwise to increase the voltage.

**NOTE:** Changes are in 50 volt intervals.

***3b*** Press **INC/DEC** on the hand controller to adjust the output voltage. Press **STOP** on the hand controller to disable high voltage.

**NOTE:** The hand controller **UP/DOWN** buttons are only active in the high voltage, emission current, and filament current setpoint adjustment modes. The **STOP** button is always active, as is the front panel **HV OFF** button.

***4*** Press the control knob (**DONE**) to save changes. The **Runtime** screen is displayed.

**NOTE:** If changes are not saved, HVPS/SC will automatically return to the previously set output voltage value.

**HINT:** Press the top selection button (**UNDO**) to restore the previously set output voltage value prior to pressing **DONE**.

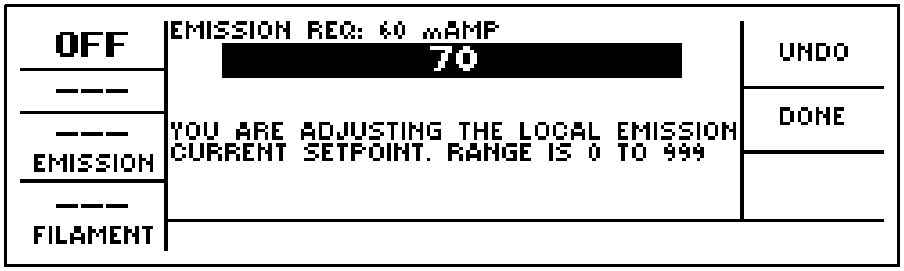
### *3.5.2 Editing the Emission Current*

***1*** Display the **Runtime** screen. (Refer to Figure 3-3.)

***2*** Press the control knob to select **ADJUST EC**. The **Emission Current Setpoint** screen is displayed.

**NOTE:** Changes to emission current occur immediately. The original value, before any changes were made, is displayed above the selected value. (See Figure 3-5.)

*Figure 3-5 Emission current setpoint adjustment screen.*




PN 074-611-P1B

***3*** Increase or decrease the emission current:

***3a*** Rotate the control knob counterclockwise to decrease or clockwise to increase the current.

**NOTE:** Changes are in 1 mA intervals.

***3b*** Press the **INC/DEC** buttons on the hand controller to adjust the emission current. Press the **STOP** button on the hand controller to disable emission current.

**NOTE:** The hand controller **UP/DOWN** buttons are only active in the high voltage, emission current, and filament setpoint adjustment modes. The **STOP** button is always active, as is the front panel **HV OFF** button.

***4*** Press the control knob (**DONE**) to save changes and return to the **Runtime** screen.

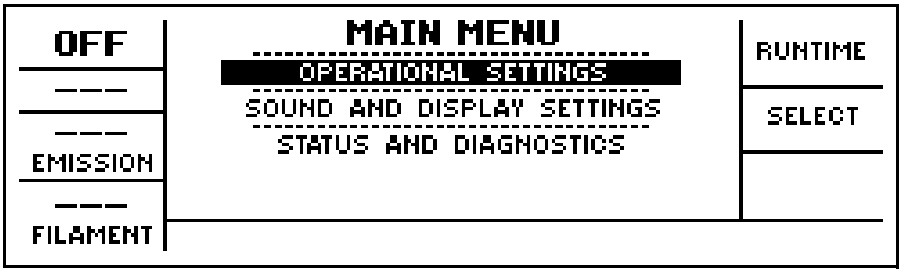
**NOTE:** If changes are not saved, HVPS/SC will automatically return to the previously set emission current value.

**HINT:** Press the top selection button (**UNDO**) to the restore the previously set emission current value.

## *3.6 Main Menu*

Press the bottom selection button on the front panel (refer to Figure 3-1 on page 3-1) to exit the **Runtime** screen and display the **Main Menu** screen. (See Figure 3-6.)

*Figure 3-6 Main Menu screen*




Rotate the control knob to select a submenu from the list. Press the control knob to display the screen for the selected submenu.

- **Operational Settings** screen. (See section 3.6.1.)
- **Sound and Display Settings** screen. (See section 3.6.2 on page 3-15.)
- **Status and Diagnostics** screen. (See section 3.6.3 on page 3-17.)

Press the top selection button on the front panel (refer to Figure 3-1 on page 3-1) to exit the **Main Menu** screen and display the **Runtime** screen.

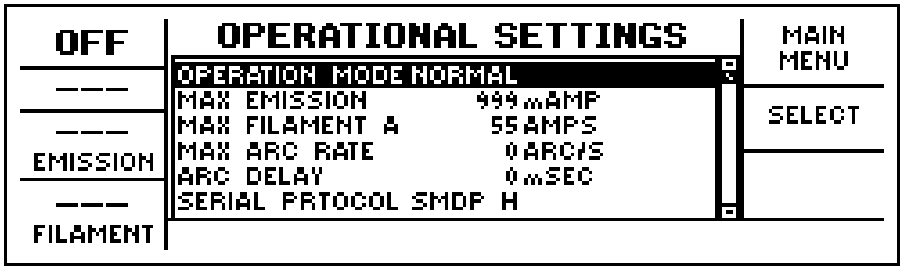
PN 074-611-P1B

### 3.6.1 Operational Settings Screen

From the **Main Menu** screen, press the control knob to display the **Operational Settings** screen (see Figure 3-7) and to edit system parameters.

Rotate the control knob to select an item from the list.

*Figure 3-7 Operational settings parameter lists*




**Operational Mode** . . . . . HV Only, FC Only, Normal

**NOTE:** HV Only and FC Only are operational modes for testing and troubleshooting.

**HV Only**

Enables high voltage only without enabling the filament. Allows high voltage to be generated and tested without filament current and e-beam generation.

**FC Only**

Allows manual control of the filament current without high voltage. Uses the filament setpoint value displayed on the **Runtime** screen. FC Only allows the low voltage filament supply subsystem to be tested (current flow, connections, feedthroughs) without high voltage being applied.

**WARNING - Risk Of Electric Shock**

**FC Only must be used with caution.**

**Normal**

Enables high voltage and filament current to generate an emission current as programmed. Normal is the HVPS/SC default mode.

**Max Emission** . . . . . 10 to 999 mA

Maximum emission current (EC) produced by HVPS/SC. (See section 3.6.1.3 on page 3-14.) Used to scale the 0 to -10 V analog input request when in **Remote** mode. If this current is exceeded, an Abort condition will occur.

**Max Filament A** . . . . . 20 to 70 A

Maximum filament current (FC) produced by HVPS/SC.

PN 074-611-P1B

**Max Arc Rate**. . . . . 0 to 50 arc/s

Maximum allowable arc rate before an Abort condition occurs.

**NOTE:** A value of 0 will disable this option.

**Arc Delay**. . . . . 0 to 1000 ms

Minimum additional time HVPS/SC will wait when an arc occurs, in addition to the standard recovery time. Programmed in 10 ms increments.

**Serial Protocol** . . . . . SMDP L, SMDP M, SMDP H

Serial communications network speed.

HVPS/SC performs serial communication using SMDP protocol at a baud rate of 9600 bps for Low speed (SMDP L), 38400 bps for Medium speed (SMDP M), or 115200 bps for High speed (SMDP H).

**SMDP address** . . . . . 16 to 254

Sets the SMDP address of the power supply. A value of 16 will use RS-232 signal levels. A value of 17 to 254 will use RS-485 signal levels. (See Chapter 4.)

Press the control knob to display the screen to edit the selected item. (See section 3.6.1.1 and section 3.6.1.2 on page 3-13.)

**ZERO Fil Hours**

Press the control knob to reset the filament hours and the filament cycles counter to zero. This is normally done when a new filament is installed to help keep track of filament longevity statistics.

**Clear Trap Code**

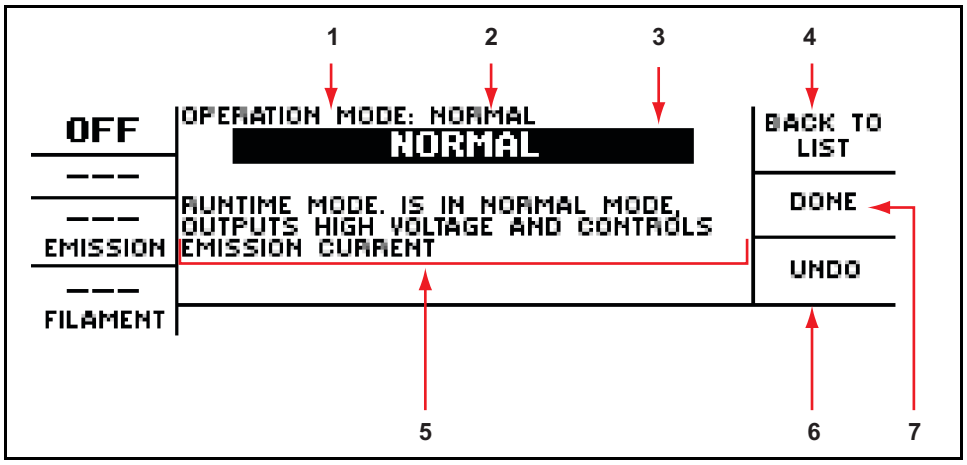
Press the control knob to clear the software warning and system trap codes. This is used to remove the history of anomalous events, so that new warnings and codes can be detected.

Press the top selection button on the front panel (refer to Figure 3-1 on page 3-1) to exit the **Operational Settings** screen and display the **Main Menu** screen.

PN 074-611-P1B

### 3.6.1.1 Editing a Parameter with Fixed Values

*Figure 3-8 Fixed value edit*




***1*** **Parameter Title**

Displays the name of the parameter selected for editing.

***2*** **Prior Value**

Displays the value programmed prior to any changes being made.

***3*** **Selected Value**

Displays current value programmed.

***4*** **Back to List**

Press the top selection button to save changes and return to the previous screen with the current parameter selected.

***5*** **Description**

Displays the range of values and an explanation of the parameter.

***6*** **Undo**

Press the bottom selection button to return to the previous value.

***7*** **Done**

Press the control knob to save changes and return to the previous screen, one list item below the parameter that was edited.

Rotate the control knob clockwise or counterclockwise to scroll the list of fixed values for the selected parameter.

**NOTE:** **UNDO** is not available after **DONE** or **BACK TO LIST** is pressed and the previous screen is displayed.

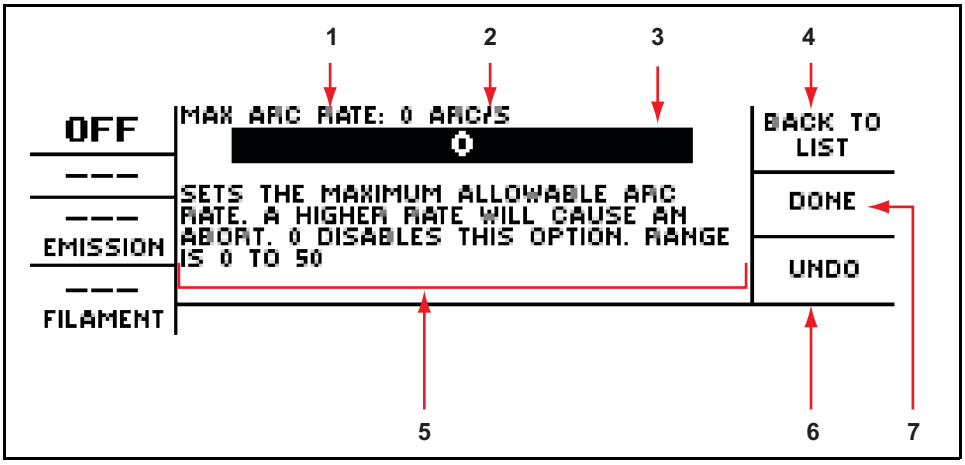
Press the bottom selection button (**UNDO**) to return current parameter changes to their previous value.

PN 074-611-P1B

Press the control knob (**DONE**) or the top selection button (**BACK TO LIST**) to save changes **and** return to the previous screen.

### *3.6.1.2 Editing a Parameter with Numeric Values*

*Figure 3-9 Numeric value edit*




***1*** **Parameter Title**

Displays the name of the parameter selected for editing.

***2*** **Prior Value**

Displays the value programmed prior to any changes being made.

***3*** **Selected Value**

Displays current value programmed.

***4*** **Back to List**

Press the top selection button to save changes and return to the previous screen with the current parameter selected

***5*** **Description**

Displays the range of values and an explanation of the parameter.

***6*** **Undo**

Press the bottom selection button to return to the previous value.

***7*** **Done**

Press the control knob to save changes and return to the previous screen, one list item below the parameter that was edited.

Rotate the control knob clockwise or counterclockwise to increase or decrease the value of the selected parameter.

**NOTE:** **UNDO** is not available after **DONE** or **BACK TO LIST** is pressed and the previous screen is displayed.

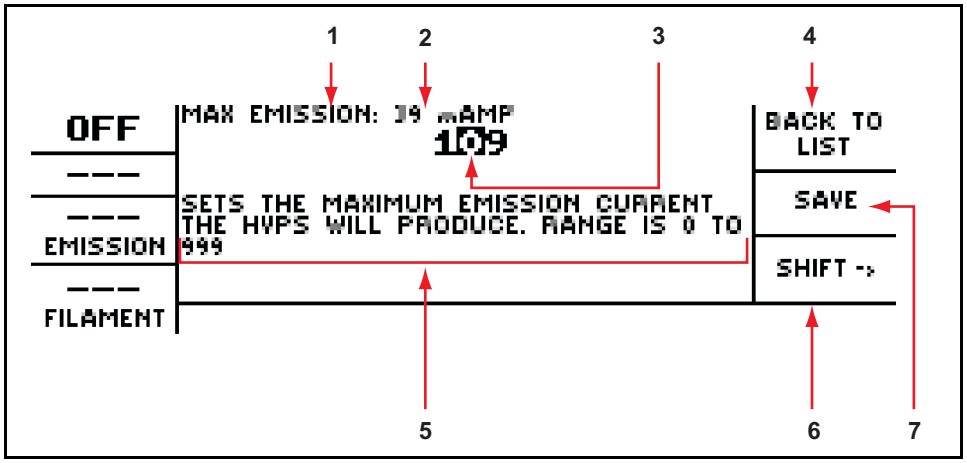
Press the bottom selection button (**UNDO**) to return current parameter changes to their previous value.

Press the control knob (**DONE**) or the top selection button (**BACK TO LIST**) to save changes **and** return to the previous screen.

**NOTE:** Value changes to the LCD contrast or brightness occur immediately.

### *3.6.1.3 Editing Maximum Emission Current*

*Figure 3-10 Maximum emission current edit*




***1*** **Parameter Title**

Displays the name of the parameter selected for editing.

***2*** **Prior Value**

Displays the value programmed prior to any changes being made.

***3*** **Selected Digit**

Displays digit selected for edit.

***4*** **Back to List**

Press the top selection button to return to the previous screen without saving changes.

***5*** **Description**

Displays the range of values and an explanation of the parameter.

***6*** **Shift**

Press the bottom selection button to change which digit is the selected digit (hundreds, tens, units).

PN 074-611-P1B

**7 Save**

Press the control knob to save changes and return to the previous screen, one list item below the parameter that was edited.

Rotate the control knob clockwise or counterclockwise to increase or decrease the value, 0 through 9, for the selected digit.

Press the bottom selection button (**SHIFT**) to select the digit to the right of the currently selected digit. When no additional digits exist to the right, press the **SHIFT** to select the leftmost digit. Press the control knob (**SAVE**) to save changes and return to the previous screen or press the top selection button (**BACK TO LIST**) to return to the previous screen without saving changes.

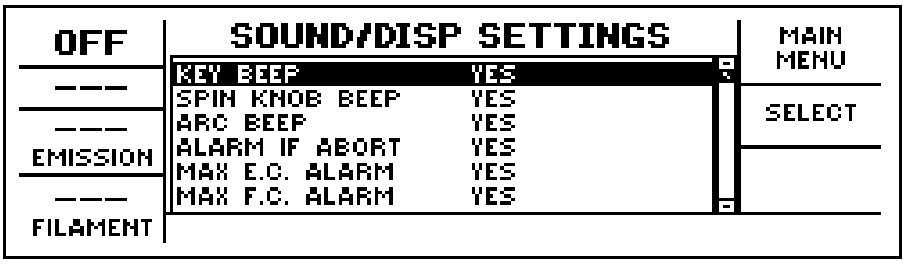
## *3.6.2 Sound and Display Settings Screen*

From the **Main Menu** screen, rotate the control knob to select **Sound and Display Settings** and press the control knob to display the **Sound and Display Settings** screen (see Figure 3-11) and edit sound and display parameters.

**NOTE:** HVPS/SC is currently shipped without an internal speaker. Editing **Sound and Display Settings** will not cause a beep or an alarm to occur.

Rotate the control knob to select an item from the list.

*Figure 3-11 Sound and Display Settings screen*




**Key Beep** . . . . . Yes/No

Enable/Disable sound when selection buttons are pressed.

**Spin Knob Beep** . . . . . Yes/No

Enable/Disable sound when the control knob is rotated.

**Arc Beep** . . . . . Yes/No

Enable/Disable sound when an arc is detected.

**Alarm if Abort** . . . . . Yes/No

Enable/Disable alarm when an Abort condition occurs.

**Max E.C. Alarm** . . . . . Yes/No

Enable/Disable alarm when the programed Max Emission current has been exceeded.

PN 074-611-P1B

**Max F.C. Alarm** . . . . . Yes/No

Enable/Disable alarm when the programmed Max Filament current has been exceeded.

**Max P.W. Alarm** . . . . . Yes/No

Enable/Disable sound when HVPS/SC reaches maximum power, indicating HVPS/SC is near extreme limit of operation or load is shorted.

**LCD Contrast** . . . . . 0 to 100

Adjusts the contrast of the LCD.

A value of 0 to 29 and 65 to 100 may not change the appearance of the display as compared to other values in that range.

**LCD Brightness** . . . . . 0 to 100%

Adjusts the brightness of the LCD.

**NOTE:** A value of 0 to 5 and 95 to 100 may not change the appearance of the display as compared to other values in that range.

Press the control knob to display the screen to edit the selected item. Rotate the control knob to increase or decrease a numerical value or scroll through a list of fixed values for the selected item.

Press the control knob (**DONE**) to save changes and return to the **Sound and Display Settings** screen, one list item below the parameter that was edited.

Press the bottom selection button (**UNDO**) to return current parameter changes to the previous value.

**NOTE:** **UNDO** is not available after **DONE** or **BACK TO LIST** is pressed and the previous screen is displayed.

Press the top selection button (**BACK TO LIST**) to save changes and return to the **Sound and Display Settings** screen with the current parameter selected.

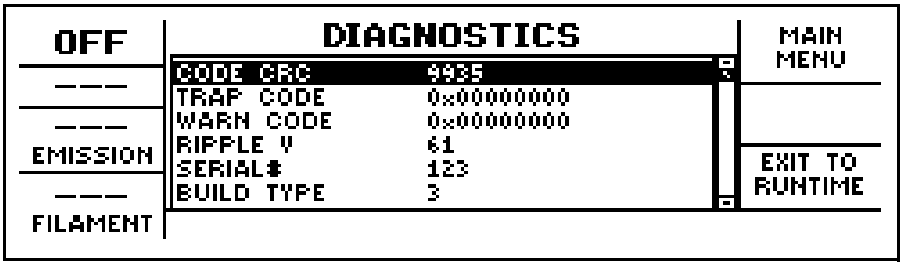
Press the top selection button on the front panel (refer to Figure 3-1 on page 3-1) to exit the **Sound and Display Settings** screen and display the **Main Menu** screen.

PN 074-611-P1B

### 3.6.3 Status and Diagnostics Screen

From the **Main Menu** screen, rotate the control knob to select **Status and Diagnostics.** Press the control knob to display the **Status and Diagnostics** screen (see Figure 3-12) and display system statistics, error codes, and version identifiers.

*Figure 3-12 Status and Diagnostics screen*




Rotate the control knob to select an item from the list.

**Code CRC** . . . . . Firmware signature value

Used to identify version of software in use with up to a five digit decimal numeric ranging from 1 to 65535. (See Table 3-2 to correlate the CRC value with a specific version and date of release.)

*Table 3-2 Software release codes*

| Revision Date | CRC Value | Version ID String | Part Number/ Hexadecimal File Signature |
|---|---|---|---|
| 2010-03-09 | 10042 | D1.7 | 524-028 0xB2AE7BB4 HVPS/SC |
| 2010-02-24 | 9935 | D1.6 | 524-028 0x8E734FF6 HVPS/SC |
| 2009-10-19 | 42009 | B1.5 | 524-028 0x4DAB0D42 HVPS/SC |
| 2009-10-02 | 63382 | B1.4 | 524-028 0x019A5B48 HVPS/SC |
| 2009-09-01 | 31872 | B1.3 | 524-028 0x5F8A7447 HVPS/SC |
| 2009-08-27 | 26891 | B1.2 | 524-028 0xB551C16F HVPS/SC |
| 2009-07-23 | 26208 | B1.1 | 524-028 0xB1CFCC83 HVPS/SC |
| 2009-07-22 | 34667 | B1.0 | 524-028 0x85986C01 HVPS/SC |

**Trap Code** . . . . . Troubleshooting code, hexidecimal 8 digits (32 bits)

If HVPS/SC reboots unexpectedly, the trap code may help determine the cause. Contact INFICON. (Refer to section 1.3 on page 1-4.)

**Warn Code**. . . . . Troubleshooting code, hexidecimal 8 digits (32 bits)

Properly working units have 0 displayed. Contact INFICON if a non-zero number is displayed. (Refer to section 1.3 on page 1-4.)

**Ripple V** . . . . . HV supply ripple voltage displayed in volts

**Serial #** . . . . . Serial number

Unique HVPS/SC identifier.

**NOTE:** The internal serial number is normally the same as the unit serial number located on the rear panel.

**Build Type** . . . . . Hardware revision/modification number

Internal identifier programmed into HVPS/SC during manufacturing.

**HV on Time** . . . . . h:mm:ss

Time HV has been enabled.

**NOTE:** Maximum displayed is 9:59:59. Internal memory will retain higher values. This can be queried using remote communications, but cannot be reset. (See section 4.5.3.1 on page 4-15.)

**Total Arcs** . . . . . Total number of arcs that have occurred. This cannot be reset.

**FC Cal mA** . . . . . Filament current value in mA

Internal HVPS/SC measurement of FC.

**Raw AIn mV** . . . . . Analog input value in mV

Scaled 0 to -10 volt analog input voltage expressed in mV from 0 to 10000 mV (0 to 100% of programmed full scale emission current setpoint). Used with a thin film deposition controller to implement control loop.

**Rem EC Req** . . . . . Remote emission current requested in mA

Result of the scaled analog input and the programmed full scale emission current setpoint.

**P12V mV** . . . . . Positive 12 V supply value in mV

**IO Faults** . . . . . Number of I/O event errors detected

Press the top selection button on the front panel (refer to Figure 3-1 on page 3-1) to exit the **Status and Diagnostics** screen and display the **Main Menu** screen.

Press the bottom selection button on the front panel (refer to Figure 3-1 on page 3-1) to exit the **Status and Diagnostics** screen and display the **Runtime** screen.

PN 074-611-P1B

# Chapter 4
# Communications

## 4.1 Communications Connections

HVPS/SC can be controlled remotely with the:

- USB connection on the front panel (refer to section 3.1 on page 3-1) using a standard USB cable (not provided).
- RS-232/RS-485 network connection on the rear panel using the RS-232 cable (PN 783-506-000-P1) provided in the ship kit. (Refer to section 2.5.1 on page 2-14.)

### 4.1.1 RS-232/RS-485 Connection

RS-232 and RS-485 serial communication ports are accessed through the RS-232/485 connector. (See Figure 4-1.)

*Figure 4-1 Network connection*




### 4.1.2 RS-232 Point-to-Point Mode

HVPS/SC can be set to RS-232 point-to-point mode for a single host-slave connection by selecting SMDP address 16 (hexadecimal 10).

Point-to-point mode can be set to one of three baud rates (SMDP H-115200, SMDP M-38400, SMDP L-9600) in the **Operational Settings** screen. (Refer to section 3.6.1 on page 3-10.) This supports a three wire (transmit, receive, common ground) interface that can be directly connected to most RS-232 ports of a computer or controller. The protocol is standard 10 bit (1 start bit, 8 data bits, 1 stop bit.) (See section 4.2 on page 4-4.)

RS-232 pin assignments for the PN 783-506-000 cable (see Figure 4-2) are Pin 2 (TXD), Pin 3 (RXD), and Pin 5 (Signal GND). Cable wiring is straight-through (not null modem).

PN 074-611-P1B

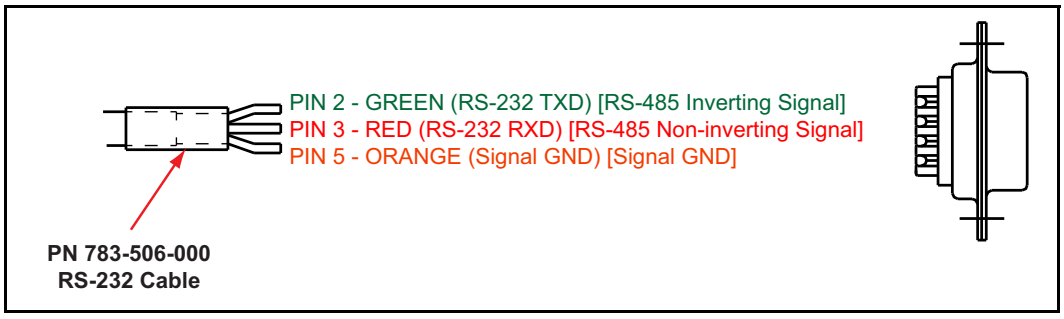
### 4.1.3 RS-485 TTL Differential Signaling Mode

RS-485 TTL differential signaling mode is selected by SMDP address values 17 through 254. In TTL differential signaling mode, two wires are time-shared (half-duplex) between a master and 1 to N slaves. Slaves monitor the state of the A/B differential signals, looking for the master to transmit a frame (start-data-stop-start-data-stop-etc). When a slave receives a frame that is addressed for it (address byte value 17 to 254), the slave will drive the A/B wire pair differentially with its own reply frame, which the master (and all other slaves) will see. Since the reply has an address byte embedded in it, other slaves will ignore the reply. The host will decode and verify (via checksum) the reply. If acceptable, the reply will be used by the master.

When using the PN 783-560-000 cable for RS-485 communication, the pin assignments are Pin 2 - **Green** (inverting signal), Pin 3 - **Red** (non-inverting signal), and Pin 5 - **Orange** (Signal GND). The RS-485 / TIA-485 standard does not specify pin assignments. A modification may be needed at the cable end connected to the RS-485 card. Refer to the user-supplied RS-485 card operating manual to determine which pins are inverting and non-inverting.

**NOTE:** If the inverting and non-inverting signal connections to the RS-485 card are reversed, the RS-485 link will not communicate; HVPS/SC and the RS-485 card will not be damaged.

*Figure 4-2 PN 783-506-000 cable for RS-485*




**CAUTION**

**The RS-485 communications interface must be wired properly with the same baud rate used for all HVPS/SC on the same network. A unique SMDP address must be used for each connected HVPS/SC on the same network.**

PN 074-611-P1B

### 4.1.4 Electrical

The HVPS/SC SMDP interface is two-wire RS-485 providing a single master, multi-slave, half-duplex network. HVPS/SC can also implement this protocol over an RS-232 interface. This allows HVPS/SC to be used for RS-232 or RS-485 networks and makes an upgrade path from point-to-point.

In point-to-point RS-232 mode, the transmit and receive data lines are converted to logic levels with a standard RS-232 transceiver.

In RS-485 bus mode, a two-wire bus uses lines designated as inverting and non-inverting and carries complementary Transistor-Transistor Logic (TTL) level differential signals, time-shared (half-duplex) for messages to and from the master. When the line is idle, the non-inverting signal line is at a TTL high.

### 4.1.5 RS-485 Line Signal

The first bit, a start bit, is a data zero value, with the non-inverting signal line going to a logic low (<1 volt). The opposite differential signal (inverting RS-485) goes to a logic high (>2 volts) during the same start bit time.

**NOTE:** After the start bit, the eight data bits are presented in order from least significant bit (D0) through most significant bit (D7), and then followed with a stop bit (logic 1 value).

The values of the ASCII code bits as 1 or 0 are represented as normal logic (1 is high TTL, 0 is low TTL) on the non-inverting RS-485 line.

For example, the opening protocol character STX (ASCII 0x02) is transmitted on the non-inverting RS-485 wire START0-0-1-0-0-0-0-0-0-STOP1. This can be examined on an oscilloscope.

### 4.1.6 Bit Time

At a baud rate of 115200 bps, for example, a bit time is 8.68 microseconds (μs). The start and LSB zero values together would hold the line low for 2*8.68 μs or 17.36 μs. The D1 bit value of one would take the line high for 8.68 μs.

The remainder of the frame data bits are a zero value, until the final stop bit one value returns the line to the Idle / 1 / Marking state. At the end of the master transmission, the line driver for the master enters a high-impedance, inactive state, so that the slave can reply over the same two wires by sending back a similarly encoded frame.

PN 074-611-P1B

## 4.2 Sycon Multi-Drop Protocol (SMDP)

SMDP is a byte-packet, binary protocol. All eight bits of the data of a byte/character are used. Standard asynchronous serial conventions apply. The link must be configured for one start bit, eight data bits, and one or more stop bits. The logic polarity and bit order adopt the standard used for asynchronous serial communications. (Refer to section 4.1.5.) A packet begins with STX (ASCII hexadecimal 02) and ends with CR (carriage return, hexadecimal 0D).

The SMDP specification provides several common, mandated command codes. HVPS/SC responds to these common messages. For example, the reset command will cause HVPS/SC to reboot, as though power was cycled. Another common command queries the product type or ID. This command (hexadecimal 30) will return an ASCII integer code that identifies the product type. (See section 4.2.1.2 on page 4-6.) This allows a master computer to poll a network and locate devices by their types and ensure that the proper connection and commands are used for the appropriate product.

**NOTE:** Each field in angle brackets (< >) is a byte and is not optional. Fields in regular brackets ([ ]) are optional. Ellipses (...) mean one or more of the previous.

### 4.2.1 Command Format

**<STX><ADDR><CMD_RSP>[<DATA>...]<CKSUM1><CKSUM2><CR>**

**STX** . . . . . Start of text character (hexadecimal 02)

Multiple STX characters in a row are allowed. Data between STX characters is ignored. A single STX character initializes the receiver to receive a new message, purging any data collected since the last STX character or carriage return received.

**ADDR**. . . . . One byte address field

The address (ADDR) byte identifies the SMDP address (refer to section 3.6.1 on page 3-10) in order to select which device the command/query is sent to.

**NOTE:** RS-485 communication limits the number of attached devices to 32. Each connected instrument must be assigned a unique address. The slave reply repeats the address when it replies to the master, verifying the address of the instrument receiving the command.

The range of values are hexadecimal 10 to FE (16 to 254 decimal).

Address hexadecimal FF is reserved. It is used as an extension to indicate another byte of address information follows for products that have an address range higher than an address of hexadecimal FE.

PN 074-611-P1B

**CMD_RSP** . . Command/Response field

When a command is sent from master to slave, the RSPF bit is zero and the RSP field (3 bits) is zero.

When a command is received from a slave to a master, CMD bits are the same as in the message that was sent. (See section 4.2.1.2.) The RSP2 through RSP0 field will be non-zero, indicating actual unit response status. (See section 4.2.1.3.) The slave will set or clear the RSPF flag bit in the reply CMD_RSP frame to indicate an unacknowledged slave reset. This bit only has meaning when a command is going from slave to master. If this bit is 1, the slave has been reset since the last AckPF, acknowledge power fail flag command was received. (See Table 4-1.)

*Table 4-1 Command/Response*

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| CMD3 | CMD2 | CMD1 | CMD0 | RSPF | RSP2 | RSP1 | RSP0 |

**DATA** . . . . . Optional data

STX, BEL (hexadecimal 07), and carriage return characters are not allowed in the data field without byte stuffing translation.

To send a data byte valued as hexadecimal 02, send the protocol escape character (hexadecimal 07) followed by an ASCII zero (hexadecimal 30).

To send a data byte valued at hexadecimal 0D, send the protocol escape character (hexadecimal 07) followed by an ASCII one (hexadecimal 31).

To send a data value of hexadecimal 07, send the protocol escape character (hexadecimal 07) followed by an ASCII two (hexadecimal 32).

The protocol escape character cannot be sent as a single byte, but can only be sent as the first byte of a pair, followed by an ASCII 0, 1, or 2.

If the protocol escape character is seen but is not followed by an ASCII 0, 1, or 2, the packet is invalid and is ignored.

**CKSUM1,2** . . Checksum characters for the message

This is the mod-256 checksum of the command binary message data. The checksum does not include STX and carriage return, and it is calculated over the actual raw message byte stream content before escape character byte stuffing. (See section 4.2.1.1.)

PN 074-611-P1B

#### 4.2.1.1 Checksum

- Compute the mod 256 checksum of ADDR, CMD_RSP, and DATA fields before byte stuffing with escape characters. This is the logical content (payload) of the command.
- CKSUM1 is the upper (most significant) four bits of the checksum (read as a nibble, 0 through 15, or right justified) plus hexadecimal 30 (ASCII zero). This yields an ASCII character from zero (hexadecimal 30) to ? (hexadecimal 3F).
- CKSUM2 is the lower (least significant) four bits of the checksum plus hexadecimal 30 (ASCII zero). This yields an ASCII character from zero (hexadecimal 30) to ? (hexadecimal 3F).

  **NOTE:** If the checksum of the command is invalid (in form or value), the packet is invalid and is ignored.



**CAUTION**

**Invalid commands (bad checksum, too short, corrupt data, bad escape sequences) are ignored by slaves and masters. No response is sent by the slave.**

#### 4.2.1.2 Command Packet Format

**<STX><ADDR><CMD_RSP>[<DATA>...]<CKSUM1><CKSUM2><CR>**

Where <CMD> is the numeric value below entered in the upper 4 bits (nybble) of the CMD_RSP byte, with the lower 4 bits all 0.

For example, the CMD_RSP byte transmitted for a Version query is hexadecimal 40 (@). The AckPF is hexadecimal 60 (`).

| | | |
|---|---|---|
| **1** | BOOT_API | Prefix for commands exclusively used to communicate with a sandal-loader/bootloader parser running on a target platform.<br>**NOTE:** HVPS/SC will consider this to be invalid (Err_Inv_Cmd). |
| **2** | Reserved | Reserved for future use in protocol stack. |
| **3** | Prod_id | Product identifier, returned as decimal string.<br>**NOTE:** The value for HVPS/SC is 20 decimal. |
| **4** | Version | Request slave to return software version string. |
| **5** | Reset | Request slave to reset/reboot. |
| **6** | AckPF | Request slave to acknowledge power failure flag and clear RSPF bit. |

PN 074-611-P1B

| | | |
|---|---|---|
| **7** | PROTV | Request slave to return protocol stack version as decimal string. |
| **8** | Product_Specific | Application API prefix to precede HVPS/SC commands. (See section 4.5 on page 4-13.) |

**NOTE:** SMDP will respond to commands in the range of 1 through 7. Commands 2 through 7 are handled in the protocol, at the protocol layer. Applications are not to use commands 2 through 7 except to implement the protocol specification.

#### *4.2.1.3 Response Packet Format*

**<STX><ADDR><CMD_RSP>[<DATA>...]<CKSUM1><CKSUM2><CR>**

**NOTE:** In the CMD_RSP byte, the CMD bits are unchanged from the master, but the RSP bits are filled in according to the status of the slave.

Where <RSP> is the lower 4 bit nybble of the CMD_RSP byte (RSP2 to RSP0) encoding the numeric value 1 to 6 and the RSPF Reply Status Power Fail flag. The upper 4 bits contain the command field value as transmitted by the Master.

| | | |
|---|---|---|
| **1** | OK | Command understood and executed. |
| **2** | Err_Inv_cmd | Illegal command (CMD code not valid). |
| **3** | Err_syntax | Syntax error (too many bytes in data field, not enough bytes, invalid characters). |
| **4** | Err_range | Data range error. |
| **5** | Err_inh | Inhibited. This can occur when trying to change/modify a read only value. |
| **6** | Err_obso | Obsolete command. No action taken. |

PN 074-611-P1B

### 4.2.2 Optional Serial Command Mode

SMDP (version 3 and greater) allows for a serial number in the command to associate a command from the master with the correct response. This detects errors in serial communications ports where commands are queued and sent out of order. The protocol structure is nearly identical to section 4.2, Sycon Multi-Drop Protocol (SMDP), on page 4-4, except:

- A serial number byte must be placed before the checksum bytes. This must be a value greater than or equal to hexadecimal 10 (16). (See section 4.2.2.1.) This byte is summed as a part of the packet payload in computing the packet checksum value.
- The checksum character base must be hexadecimal 40 (@), instead of hexadecimal 30 (0) to inform the slave that it is receiving a packet with the extra SRLNO field postamble. This makes the last two characters of the command (the checksums) range from @ (hexadecimal 40) through the letter, O (hexadecimal 4F).
- For a response, the slave places the corresponding SRLNO byte into its response packet just before the two reply packet checksum characters, also hexadecimal 40 based.

In order for this serial command mode to be effective, the master should generate a new SRLNO value for each command that it sends (modulo 255, and greater than hexadecimal 10). This allows for 240 unique serial number values before repeating. The value could be an incrementing tag that rolls over from 255 to 16 with the understanding that there would never be 240 outstanding messages. Alternatively, the tag could have a unique value or range of values for each line of communication to the product at a specific address. This will allow the responses to be received by the proper line of communication.

**NOTE:** When an SMDP response packet is received by the master, verify the SRLNO value and use it to associate it with the source of the command/query. This will prevent out-of-sequence replies from being misinterpreted and invalid results being generated.

PN 074-611-P1B

#### 4.2.2.1 Optional Serial Command Format

**<STX><ADDR><CMD_RSP>[<DATA>...]<SRLNO><ACKSM1><ACKSM2><CR>**

**SRLNO**. . . . . Serial Number

Associates a command from the master with the correct response. The value must be greater than or equal to hexadecimal 10 (16) in order to not be mistaken as a framing or escape character byte.

**ACKSM1, 2** . Alternate hexadecimal 40 based checksum characters

This has a range of values from @ (hexadecimal 40) through the letter, O (hexadecimal 4F).

**NOTE:** Refer to section 4.2.1 on page 4-4 for additional information identifying the bytes in this command string.

## 4.3 Communication Library

SMDP control is an ActiveX library that implements SMDP.

SMDP is built as an out-of-process server and automatically manages multiple sessions with multiple programs. All programs that use SMDP control can share the communication link without interference or crosstalk. It is possible to have multiple programs communicating with the same instrument, transparent to the user.

Using SMDP control is a standard ActiveX control for Windows computers.

**NOTE:** Since all programming environments have different ways to integrate ActiveX controls, linking to the control will not be covered.

Most programming environments can use ActiveX controls (i.e., Delphi, Visual Studio (vb,vc++, etc), LabVIEW, and many others). SMDP_SVR is the name of the ActiveX control library for all programming environments.

An instance of the control should be initiated for each instrument being controlled and communicated with remotely, the parameters set accordingly, and DoTransaction called to do the communications.

SMDP control handles multiple instances on the same communications port and multiple instances for the same instrument.

PN 074-611-P1B

### 4.3.1 Methods

**Open** . . . . . (file name)

Attempts to acquire communications port and allocate resources. Open does not need to be called; if the port was not opened it will automatically be opened when the DoTransaction function is called.

**DoTransaction** . . . . . (addr, SmdpCmd, Msg, Rsp, resetflag)

Initiates communication with HVPS/SC and waits for a reply (or timeout) before returning.

In: addr is the SMDP address of target instrument.

In: SmdpCmd is the SMDP command opcode enumeration constant. The value to use is based on the CMD_RSP most significant nibble value, less one. For example, a hexadecimal 60 AckPF command will pass a value of 5 as the SmdpCmd code.

**NOTE:** All command codes for DoTransaction SmdpCmd argument are one less than the CMD3 to CMD0 bit field used in the SMDP packet. (Refer to Table 4-1 on page 4-5.)

In: Msg is the message to send, may be a string or byte array.

Out: Rsp is string response from instrument.

Out: Boolean resetflag is true if instrument has been reset since the flag was acknowledged last.

**Close()** . . . . . Clears resources associated with the instance. Will also close the communications port if there are no instances communicating on the port.

**NOTE:** In most cases it is not necessary to call this function. The programming environment will unload the control when it is finished, and the control automatically closes the resources when it is unloaded.

PN 074-611-P1B

### 4.3.2 Communication Properties

**ComPortNo** . . . . . The Windows communications port to use for communication to HVPS/SC.

**Baud** . . . . . The baud rate. Valid baud rates are 9600, 38400, or 115200 bps.

**Protocol** . . . . . The protocol to use. SMDP Protocol is selected with a value 0.

**DoPacketStamp** . . . . . Set true to use SMDP-II protocol with the optional sequential packet serial stamp. (Refer to section 4.2.2.1 on page 4-9.)

**NOTE:** This should always be true.

**TimeoutMS** . . . . . Sets the number of milliseconds to wait for the instrument to respond before the control displays a timeout error during DoTransaction(). The valid range is 150 to 20000 milliseconds (defaulted at 150 ms).

**LastTimeTransSec** . . . . . The amount of time the last DoTransaction() call took to complete, in floating point (real) seconds. Typical values are in the range of 0.002 to 0.014 seconds.

**NOTE:** Some behaviors take longer to execute.

### 4.3.3 Other Properties

**Numinstances** . . . . . The number of instances of the control or number of users on the communication server.

**Build** . . . . . The build number of HVPS/SC (unique version identifier).

These properties are read only and return the same value across all instances.

PN 074-611-P1B

## 4.4 Windows/SMDP Server Implementation

SMDP server on Windows message timeout is typically 150 milliseconds. That is, after the host sends a command, it waits 150 milliseconds for a reply. If no complete reply is returned from HVPS/SC in that time, the message is considered lost. This could indicate the following:

- HVPS/SC is offline.
- The cable is disconnected.
- The baud rate or SMDP address value is invalid/mismatched.
- There is noise corrupting the packet/checksum integrity.

After 150 milliseconds have elapsed, the host can try again.

**NOTE:** Once a valid connection to HVPS/SC is made, the command/response exchange will proceed at the fastest speed, sending a new command as soon as the prior answer has come back to the host.

If there is a loss of a packet due to noise, software error, or power loss to HVPS/SC, the loss will be detected when a valid reply packet is not returned within the 150 millisecond timeout.

Retries or resending commands can continue to take place until a valid reply is returned once the 150 millisecond timeout has been reached.

PN 074-611-P1B

## 4.5 Communications Commands

HVPS/SC uses command prefix hexadecimal 80 to introduce command sequences. The data payload that follows hexadecimal 80 are standard ASCII character sequences. This vocabulary is documented in section 4.2.1, Command Format, on page 4-4.

Common commands have the same initial character sequences and are distinguished by variable numeric arguments which further specify the intended action or target of the command/query.

Therefore, only the data payload content which distinguishes these commands are found in this section.

All responses conform to the SMDP specification (refer to section 4.2 on page 4-4) with the lower four bits of the returned <CMD_RSP> byte being a non-zero value in the range of 1 to 14. The upper 4 bits are the same as the host command group (CmdOpcode_xxx), 3 to 8. The lower three bits have the value 1 to 6 as defined in section 4.2.1.3 on page 4-7. This value indicates whether the receiver could process the query. If the address is not matched with a slave, the checksum of the frame fails, or the command is otherwise improper, no response is returned by the slave.

The fourth bit (D3, 8 weight) is a power fail flag bit. The slave replies with this bit set when the platform has been reset, until such a time as the master sends one of the following:

- Acknowledge-power-fail command (CmdOpcode_ACKPF 0x60), low level SMDP message
- USRAPI_ackPfail (?) command, application specific command (hexadecimal 80)

The message from the master clears the power fail flag such that the status bit, D3, of all subsequent replies is now zero. This allows the master to detect at the earliest transaction (first valid communications after reboot/reset) that the slave device has been reset and needs to be re-synchronized. This might be considered a fatal error (power supply was reset and system state harmed), a soft error which can be recovered from, or a non-issue requiring no intervention.

PN 074-611-P1B

### 4.5.1 Command: ?

Command Type . . . . . Acknowledge

Command Structure . . . . . USRAPI_ackPfail

Syntax . . . . . ?

Description . . . . . Clears the power fail status flag.

### 4.5.2 Command: @

Command Type . . . . . Query

Command Structure . . . . . USRAPI_atQuery

Syntax . . . . . @

Description . . . . . Queries the version.

Reply Example . . . . . EBDFS D1.7

Syntax . . . . . @1

Description . . . . . Displays copyright string.

Reply Example . . . . . COPYRIGHT SYCON INSTRUMENTS 2010. X EBDFS D1.7

Syntax . . . . . @4635302

Description . . . . . Purges system trap and warning codes.

### 4.5.3 Command: C/D

Command Type . . . . . Query

Command Structure . . . . . USRAPI_RD_IEC_C

Syntax . . . . . Cn,0

Description . . . . . Queries HVPS/SC parameters, where n is the numeric identifier of the parameter.

Command Type . . . . . Update

Command Structure . . . . . USRAPI_WR_IEC_D

Syntax . . . . . Dn,0,value

Description . . . . . Updates HVPS/SC parameters, where n is the numeric identifier of the parameter and value is the numeric input.

Parameters. . . . . (See section 4.5.3.1, section 4.5.3.2, section 4.5.3.3, section 4.5.3.4, section 4.5.3.5, and section 4.5.3.6 for available parameters.)

PN 074-611-P1B

#### 4.5.3.1 C Parameter: Counters/Statistics

The parameters found in Table 4-2 are read-only. (Refer to section 4.5.3.)

*Table 4-2 Counters/statistics*

| n | Name | Description |
|---|---|---|
| 51255 | FILCYC | Total number of filament cycles |
| 13850 | FILSEC | Total number of filament seconds |
| 31127 | HVSEC | Total number of HV seconds |
| 34906 | TOTARCS | Total number of arcs |

#### 4.5.3.2 C/D Parameter: Display/Sound Controls

*Table 4-3 Display/sound controls*

| n | Name | Description | Comment |
|---|---|---|---|
| 29656 | ALRM_ABORT | Alarm if aborted for any reason | 0 False/No<br>1 True/Yes |
| 34195 | ALRM_MAXEC | Alarm if maximum emission current reached | 0 False/No<br>1 True/Yes |
| 54864 | ALRM_MAXFC | Alarm if maximum filament current reached | 0 False/No<br>1 True/Yes |
| 47098 | ALRM_MAXPW | Alarm if maximum power reached | 0 False/No<br>1 True/Yes |
| 36291 | ARCBEEP | Beep on arc | 0 False/No<br>1 True/Yes |
| 28557 | KEYBEEP | Beep if button is pressed | 0 False/No<br>1 True/Yes |
| 56847 | LCDBT | LCD brightness | 0 to 100 |
| 61262 | LCDCT | LCD contrast | 0 to 100 |
| 64198 | SPINBEEP | Beep on spin knob turn | 0 False/No<br>1 True/Yes |

PN 074-611-P1B

#### 4.5.3.3 C/D Parameter: Operational Controls

*Table 4-4 Operational controls*

| n | Name | Description | Comment |
|---|---|---|---|
| 28767 | LECSP | Local emission current setpoint | 10 to 999 mA |
| 57265 | LFCSP | Local filament current setpoint | 20 to 70 mA |
| 51481 | LHVSP | Local HV setpoint | 4000 to 10200 V in 50 V increments |

#### 4.5.3.4 C Parameter: Runtime Results/Feedback

The parameters found in Table 4-5 are read-only. (Refer to section 4.5.3 on page 4-14.)

*Table 4-5 Runtime results/feedback*

| n | Name | Description | Comment |
|---|---|---|---|
| 07631 | ARCS | Total arcs this run | Read-only |
| 48306 | ARCS_SEC | Current arc rate | arcs per second |
| 10813 | BAIL_PREFL | Abort status during preflight | See section 4.5.3.4.1 on page 4-18 for stop codes |
| 46498 | CRNTERR | Current highest priority error | See section 4.5.3.4.1 on page 4-18 for stop codes |
| 48681 | EC_MON | Emission current | mA |
| 2412 | EC_MON_FAST | Emission current raw, quick sampled | mA |
| 61509 | FILON | Status of filament | 0 False/Off<br>1 True/On |
| 38080 | HVMSTATE | Status of the HVM state variable | See section 4.5.3.4.2 on page 4-19 for HVM state variables |
| 55628 | HVON | Status of HV | 0 False/Off<br>1 True/On |
| 46341 | HV_MON | HV output | V |
| 36202 | ILOK_ALL | All interlocks satisfied | 0 False/No<br>1 True/Yes |
| 61455 | ILOK_AUX | Auxiliary interlock satisfied | 0 False/No<br>1 True/Yes |
| 04109 | ILOK_COVER | Cover interlock satisfied | 0 False/No<br>1 True/Yes |
| 32112 | ILOK_HOT | Overtemperature interlock satisfied | 0 False/No<br>1 True/Yes |

PN 074-611-P1B

*Table 4-5 Runtime results/feedback (continued)*

| n | Name | Description | Comment |
|---|---|---|---|
| 49486 | ILOK_IP5V | Internal +5 V present | 0 False/No<br>1 True/Yes |
| 34896 | ILOK_SRC1 | External SC connected and powered up | 0 False/No<br>1 True/Yes |
| 55786 | ILOK_SRC2 | All external interlocks are satisfied | 0 False/No<br>1 True/Yes |
| 60977 | IO_REMOTE | Status of remote/local mode | 0 False/Local<br>1 True/Remote |
| 14043 | IO_REMRUN | Status of external remote run line | 0 False<br>1 True |
| 63885 | LIVE_ECSP | Current emission current setpoint request satisfied | 0 False/No<br>1 True/Yes |
| 58484 | P12V | 12 V monitor | mV |
| 13591 | PEND_INP_RAWDAT | 8-bit raw data from I 2c expander for hand controller inputs | Read-only |
| 17609 | REM_ECSP | Remote emission current setpoint request satisfied | 0 False/No<br>1 True/Yes |
| 01018 | RPV_RAW_MV | Raw voltage as read at the rear panel | mV |
| 14763 | RUNELAP | Amount of time for current or last run | s |
| 30494 | SCO_FCMON | Filament current monitor | A |
| 48760 | SMS_IO | The final, simple state of the I/O state machine | Troubleshooting code |
| 52754 | STOPREASON | Reason the HVPS was aborted or stopped | See section 4.5.3.4.1 on page 4-18 for stop codes |
| 31326 | VSS_REMREADY | Status of the I/O state | 0 False/Not Ready<br>1 True/Ready |
| 02862 | V_RIPPLE | Ripple voltage | V |

#### 4.5.3.4.1 Stop Codes

| | | |
|---|---|---|
| **0** | none | Running, not stopped |
| **1** | ERRP12V | +12 V out of range |
| **2** | ERRRIPL | High voltage output excessive ripple |
| **3** | ERRHVREG | High voltage output not within 10% of setpoint |
| **4** | ERRHSHOT | Heatsink too hot |
| **5** | ERRHVH | High voltage too high |
| **6** | ERRECH | Emission current too high |
| **7** | ERRFCH | Filament current too high |
| **8** | PREF_CONTK1 | Contactor failed to open |
| **9** | PREF_CLMPL | Clamp low test failed |
| **10** | PREF_CLMPH | Clamp high test failed |
| **11** | PREF_CONTK2 | Contactor failed to close |
| **12** | PREF_REGF | Regulation failure |
| **13** | PREF_FILCUR | No filament current detected |
| **14** | PREF_HVPRES | High voltage present but should not be |
| **15** | PREF_ECPRES | Emission current present but should not be |
| **16** | PREF_FCPRES | Filament current present but should not be |
| **17** | ERROPNCONTK | Contactor opened while running without reason |
| **18** | ERRPREF | Error occurred during preflight. BAIL_PREFL parameter has reason code. (Refer to section 4.5.3.4 on page 4-16.) |
| **19** | ARCRATE | Arc rate exceeded |

PN 074-611-P1B

#### 4.5.3.4.2 HVM State Variables

| | | |
|---|---|---|
| **0** | offidle | HV is off<br>**NOTE:** Remains in this state while HV is off. |
| **1** | begin | Sequences through state 18 when HV is turned on. Advances in order while successful. In the event of a failure, advances to state 20 where it remains until error is cleared or a restart is attempted.<br>**NOTE:** Set the state variable to one to begin the sequence. |
| **2** | delay1 | Time delay for hardware changes to occur |
| **3** | chkcontopn | Verify contactor is open |
| **4** | iniset1 | Set power clamp to zero and HV request to -4 kV |
| **5** | chkclamp1 | Verify power is low (near 0%) |
| **6** | iniset2 | Set clamp to 100% |
| **7** | chkclamp2 | Verify power is high (near 100%) |
| **8** | iniset3 | HV off, clamp = 35%, HV request = -4 kV, contactor closed |
| **9** | chkcontact | Waiting for contactor to close to satisfy interlocks |
| **10** | delay2 | Contactor now closed, wait to obtain HV or FC measurements |
| **11** | chknohv | Tests the digital control line to verify no HV |
| **12** | chknoec | Tests the digital control line to verify no EC |
| **13** | chknofc | Tests the digital control line to verify no FC |
| **14** | iniset4 | FC on (digital line) |
| **15** | chkFC | Waiting for filament current |
| **16** | iniset5 | Turn HV on (digital line) |
| **17** | chkregl | Verify voltage set in iniset2 is achieved |
| **18** | endsucc | State machine completed successfully; normal state; controlling HV/EC and/or FC; remains here until HV is turned off. |
| **19** | contakwait | Was running, contactor opened, turned off immediately; advances to bail state |
| **20** | bailed | Requires a stop and start to exit this state and resume (sets error code) |

PN 074-611-P1B

### 4.5.3.5 C/D Parameter: System

*Table 4-6 System*

| n | Name | Description | Comment |
|---|---|---|---|
| 39144 | ARCDELAY | Minimum arc delay | 0 to 1000 ms in 10 ms increments |
| 46459 | ARCRATE | Maximum arc rate | 0 to 50 arcs/s |
| 30240 | MAXEC | Max emission current | 10 to 999 mA |
| 09699 | MAXFC | Max filament current | 20 to 70 A |
| 10063 | SYSMODE | Operational mode | 0 Normal HV and FC<br>1 HV Only<br>2 FC Only |
| 24855 | SYSPROT | Baud Rate | 0 SMDP H 115200 bps<br>1 SMDP M 38400 bps<br>2 SMDP L 9600 bps |
| 19490 | SYSSMDPADR | SMDP Address | 16 to 254 |

### 4.5.3.6 C Parameter: Utility/Special

The parameters found in Table 4-7 are read-only. (Refer to section 4.5.3 on page 4-14.)

*Table 4-7 Utility/special*

| n | Name | Description | Comment |
|---|---|---|---|
| 11021 | CODE_SUM | Troubleshooting code | Read-only |
| 33886 | COMM_BEEP | Beep on sent communication | 0 False/No<br>1 True/Yes<br>**NOTE:** Not operational. |
| 06857 | CRC_RESULT | CRC of the firmware | Read-only |
| 02084 | HW_REV | Troubleshooting code | Read-only |
| 08441 | MEM_BLESS | Troubleshooting code | Read-only |
| 32794 | MEM_LOSS | Memory loss flag | Contact INFICON if a non-zero number is displayed. (Refer to section 1.3 on page 1-4.) |
| 36581 | PROD_BTYPE | Internal identifier | Read-only |
| 05555 | PROD_ID | Product identifier | Read-only |
| 53184 | PROD_SRNO | Internal serial number | Internal serial number is the unit serial number located on the rear panel |
| 42614 | SYS_TRAP_CODE | Troubleshooting code | Read-only |
| 11393 | WARN_CODE | Troubleshooting code | Contact INFICON if a non-zero number is displayed. (Refer to section 1.3 on page 1-4.) |

PN 074-611-P1B

### 4.5.4 Command: E

Command Type . . . . . Event

Command Structure . . . . . USRAPI_EventSig

Syntax. . . . . E1

Description . . . . . Acknowledges a memory loss and reset memory loss flag.

Syntax. . . . . E7

Description . . . . . Resets user adjustment interaction timer to zero to prevent display changes from the runtime adjustment mode (HV adjust with spin knob or handheld controller) to normal runtime display. This overrides the normal timeout safety that leaves the adjustment mode once there is no user interaction for a period of time.

### 4.5.5 Command: I

Command Type . . . . . Query

Command Structure . . . . . USRAPI_IDPortQry

Syntax. . . . . I

Description . . . . . Queries the communications port.

Response . . . . . 0 Front Panel USB
1 Rear Panel RS-232
2 Rear Panel RS-485

PN 074-611-P1B

## 4.5.6 Command Examples

### 4.5.6.1 Query System High Voltage

**<STX><ADDR><CMD_RSP>[<DATA>...]<CKSUM1><CKSUM2><CR>**

Hexadecimal example:

**<02><10><80><43><34><36><33><34><31><2C><30><33><31><0D>**

Command Type . . . . . Query

Hexadecimal . . . . . 02
Description . . . . . Start of text character (hexadecimal 02)

Hexadecimal . . . . . 10
Description . . . . . SMDP address (16 decimal)

Hexadecimal . . . . . 80
Description . . . . . Application API prefix to precede HVPS/SC commands

Hexadecimal . . . . . 43

Description . . . . . Capital C
Queries HVPS/SC parameters. (Refer to section 4.5.3 on page 4-14.)

Hexadecimal . . . . . <34><36><33><34><31>

Description . . . . . High Voltage Monitor (HV_MON) parameter value of 46341 is the hexadecimal 34 to 31 sequence. (Refer to section 4.5.3.4 on page 4-16.)

Hexadecimal . . . . . 2C

Description . . . . . Comma separator

Hexadecimal . . . . . 30

Description . . . . . Index of zero

**NOTE:** The index is zero for all HVPS/SC communication commands.

Hexadecimal . . . . . <33><31>
Description . . . . . Checksum characters for the message

Hexadecimal . . . . . 0D
Description . . . . . Carriage return packet terminator character

PN 074-611-P1B

# Chapter 5
# Maintenance and Troubleshooting

## 5.1 Maintenance

Contact INFICON for Maintenance of HVPS/SC. (Refer to section 1.3 on page 1-4.)

## 5.2 Troubleshooting

If HVPS/SC fails to function, or appears to have diminished performance, the following diagnostic charts may be helpful:

- **General HVPS/SC Troubleshooting.** (See section 5.2.1.)
- **Computer Communications Troubleshooting.** (See section 5.2.2 on page 5-3.)
- **Interlocks.** (See section 5.2.3 on page 5-4.)
- **Error Messages.** (See section 5.2.4 on page 5-5.)

PN 074-611-P1B

## 5.2.1 General HVPS/SC Troubleshooting

*Table 5-1 General HVPS/SC troubleshooting*

| SYMPTOM | CAUSE | REMEDY |
|---|---|---|
| HVPS/SC does not turn on when power button depressed | Blown fuse/circuit breaker tripped | Have qualified personnel replace fuse/reset circuit breaker. |
| | Electrical power mains not connected | Connect HVPS/SC to mains power. (Refer to section 2.1.3 on page 2-5.) |
| | Incorrect line voltage | Have qualified personnel verify line voltage and verify the HVPS/SC internal configuration. |
| HVPS/SC "locks up" | High electrical noise environment | Reroute RF cables (25.4 cm [1 ft.] away from high power conducting lines), keep all ground wires short with large surface area to minimize ground impedance. |
| | Poor grounds or poor grounding practice | Verify proper earth ground, use appropriate ground strap, eliminate ground loops by establishing the correct system grounding, verify proper HVPS/SC grounding. (Refer to section 2.1.1 on page 2-2.) |
| HVPS/SC does not retain parameters on power down (loss of parameters on power up) | Faulty non-volatile RAM | Contact INFICON. (Refer to section 1.3 on page 1-4.) |
| Some buttons on front panel function while others do not or LCD fails to function | Faulty LCD or faulty ribbon cable | Contact INFICON. (Refer to section 1.3 on page 1-4.) |
| LCD display dull or blank | LCD contrast adjustment required | Adjust LCD contrast. (Refer to section 3.6.2 on page 3-15.) |
| | LCD or power supply problem | Contact INFICON. (Refer to section 1.3 on page 1-4.) |

PN 074-611-P1B

## 5.2.2 Computer Communications Troubleshooting

*Table 5-2 Computer communications troubleshooting*

| SYMPTOM | CAUSE | REMEDY |
|---|---|---|
| Communications cannot be established between the host computer and HVPS/SC | Improper cable connection | Verify for correct cable wiring as described in section 4.1 on page 4-1. |
| | Baud rate in host computer not the same as HVPS/SC | Verify baud rate in the application program operating on the host computer matches SMDP serial protocol of HVPS/SC. (Refer to section 3.6.1 on page 3-10.) |
| | Incompatible SMDP address being used for network connection | Verify SMDP address in the application program operating on the host computer matched SMDP address of HVPS/SC. (Refer to section 3.6.1 on page 3-10.)<br><br>16 for RS-232<br>17 to 254 for RS-485 |
| Error code returned | 2 = Illegal Command | Command code not valid; some commands may not be in use. |
| | 3 = Syntax Error | The command sent is not valid; too many or too few bytes in syntax; verify command syntax. (Refer to section 4.2.1 on page 4-4.) |
| | 4 = Data Range Error | The value sent is outside the range for the given parameter, verify the range for the parameter. |
| | 5 = Command Inhibited | Some commands may not be in use or HVPS/SC state may prohibit the action at this time. |
| | 6 = Obsolete Command | No action taken; some commands may not be in use. |

PN 074-611-P1B

### 5.2.3 Interlocks

HVPS/SC will not enable HV and/or FC if the interlocks are not satisfied. (See Table 5-3.)

*Table 5-3 Interlocks*

| Interlock | Description | Remedy |
|---|---|---|
| **VAC** | Source Control input pin 5 signal not detected. | Energize Input SC-VACUUM ILOCK. (See section 2.5.4 on page 2-17.) |
| **WATER** | Source Control input pin 1 signal not detected. | Energize Input SC-WATER. (See section 2.5.4 on page 2-17.) |
| **DOOR** | Vacuum chamber door switch closure/input not detected. Any coverings or shields that isolate the high voltage wiring from human exposure should be interlocked so if removed, this interlock is not satisfied. | Energize DOOR INTERLOCK. (See section 2.5.2 on page 2-15.) |
| **COVER** | HVPS/SC cover not detected. | Replace the HVPS/SC cover. |
| **P5V** | Internal Positive 5 V power supply failed or shorted. | Contact INFICON. (Refer to section 1.3 on page 1-4.) |

PN 074-611-P1B

### 5.2.4 Error Messages

During operation, when HVPS/SC detects a fault, **ERR** is displayed as the **HV Status** on the **Runtime** screen (refer to section 3.4 on page 3-5), the Statistics and Message pane will display a message in the following form:

**<XXXX ERROR:YYYYY YYY YYYY>**

**XXXX** . . . . . Fault code. (See Table 5-4.)

**YYYY** . . . . . Explanation text. (See Table 5-4.)

*Table 5-4 Error messages*

| Fault Code | Explanation Text | Description | Remedy |
|---|---|---|---|
| **12VF** | INTERNAL 12 V BUS POWER FAILURE | Hardware failure problem detected internally, 12 V supply defective or overloaded. | Reboot HVPS/SC. If problem persists, contact INFICON. (Refer to section 1.3 on page 1-4.) |
| **RIPL** | HV OUTPUT RIPPLE TOO HIGH-CHECK 3 PHASE POWER INPUT | The output voltage ripple was too high for too long. | Verify 3-phase power input is correct. This problem can occur if one of the phases is lacking in voltage. |
| **REGL** | HV OUTPUT UNABLE TO REGULATE TO SETPOINT VOLTAGE | Regulation failure. HVPS/SC does not produce an output voltage within limits. | Verify the output is not shorted. The output can be shorted by a broken filament, debris in the gun emitter, etc. |
| **HOT1** | INTERNAL HEATSINK TOO HOT-CHECK FAN AND AIRFLOW | Temperature sensor reading exceeds maximum. | Examine fan and enclosure openings, ensure adequate airflow and proper ambient temperature conditions. |
| **OVLT** | HV OUTPUT EXCEEDED 12000V | HVPS/SC detected an output voltage exceeding 12 kV for too long. | Reboot HVPS/SC. |
| **ECHI** | EMISSION CURRENT EXCEEDED 1100mA | HVPS/SC turned off because the emission current was too high for too long. | Reboot HVPS/SC. |
| **FCHI** | FILAMENT CURRENT EXCEEDED 75A | The power supply turned off because the filament current was too high for too long. | Reboot HVPS/SC. |
| **CTK1** | STARTUP SELF TEST: CONTACTOR FAILED TO OPEN | HVPS/SC is unable to open the internal contactor relay which ensures safe operation when off. This must be corrected. | Immediately turn off mains power or circuit breaker to turn supply off and attempt to release contact.<br><br>Reestablish power and reboot power supply. |
| **PWHI** | STARTUP SELF TEST: PULSE WIDTH CLAMP LOW TEST FAILED | HVPS/SC has detected a problem with some safety circuitry. | Reboot HVPS/SC. |

PN 074-611-P1B

*Table 5-4 Error messages (continued)*

| Fault Code | Explanation Text | Description | Remedy |
|---|---|---|---|
| **PWLO** | STARTUP SELF TEST: PULSE WIDTH CLAMP HIGH TEST FAILED | HVPS/SC has detected a problem with some safety circuitry. | Reboot HVPS/SC. |
| **CTK2** | STARTUP SELF TEST: CONTACTOR FAILED TO CLOSE | Hardware failure problem detected internally, high voltage contact failed to close. | Reboot HVPS/SC. |
| **REGF** | STARTUP SELF TEST: FAILED TO REGULATE HV. MAKE SURE SUPPLY IS NOT SHORTED | Regulation failure. HVPS/SC does not produce an output voltage within limits during the initial preflight. | Verify the output is not shorted. The output can be shorted by a broken filament, debris in the gun emitter, etc. |
| **FILC** | STARTUP SELF TEST: NO FILAMENT CURRENT DETECTED DURING STARTUP.CHECK FILAMENT | The filament current supply is not delivering filament current in tolerance. | Check the filament, connections, and cabling for proper continuity. |
| **HV>0**  | STARTUP SELF TEST: HIGH VOLTAGE DETECTED DURING STARTUP | Internal error. High voltage supply circuitry produces HV when turned off. | Immediately turn off mains power or circuit breaker to turn HVPS/SC off and attempt to release contactor.<br><br>Reestablish power and reboot HVPS/SC. |
| |  **WARNING - Risk Of Electric Shock**<br><br>**A hazard exists! Dangerous voltages are present which could result in personal injury.** | | |
| **EC>0** | STARTUP SELF TEST: EMISSION CURRENT DETECTED DURING STARTUP | An emission current in excess of 10 mA is detected when no emission current should be present. | Reboot HVPS/SC. |
| **FC>0** | STARTUP SELF TEST: FILAMENT CURRENT DETECTED DURING STARTUP | A filament current in excess of 5 A is detected when no filament current should be present. | Reboot HVPS/SC. |
| **OPNK** | INTERNAL CONTACTOR OPENED UNEXPECTEDLY | Internal failure detected, HV contact relay opened during operation without a valid reason. | Reboot HVPS/SC. |

PN 074-611-P1B

# Appendix A
# Terminology

## A.1 Definitions

| | |
|---|---|
| Environmental Efficiency . . . . . | The amount of energy delivered to HVPS/SC versus the amount of energy delivered to the gun. The remaining energy is mostly lost as heat. |
| Economic Efficiency . . . . . | The environmental efficiency multiplied by the power factor. This is a figure of merit for amount of energy delivered to the gun verses the amount of energy charged by the utility. |
| Minimum arc recovery time . . . . . | Time required to detect the arc, wait for arc to extinguish, and ramp output from 0 to -10 kV. |
| Maximum Stored Energy . . . . . | Maximum stored energy with the supply at 10 kW output. |

PN 074-611-P1B

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PN 074-611-P1B

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