



IG2 Manual

(For Use With the 32-175 Control)



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Safety Notices

The equipment manufactured by RBD Instruments, Inc. (RBD) are designed with consideration of the safety of those who come in contact with them. Towards this end, we have defined the skills and knowledge that operators and maintenance personnel must have to interact with our products.

Authorized Personnel

Operators and maintenance personnel require specific skills to interact with RBD's products.

Operators of RBD equipment are expected to be familiar with the technical information and instructions provided in the included documentation. It is also expected that unless Operators have the skills and knowledge required by maintenance personnel, Operators will not attempt to repair or maintain the equipment without the assistance of someone who has such skill and knowledge.

Qualified and skilled maintenance personnel will have the following knowledge and experience:

- Training and experience with voltages above 2 kV.
- Familiarity with and understanding of the documentation included with the equipment
- Awareness, familiarity, and understanding of all safety notices and symbols that are included in the documentation and on the equipment.

Limited Warranty

RBD Instruments, Inc. (referred to as “Company”) warrants that the product(s) discussed in this document will perform substantially in accordance with the accompanying written materials and will be free from defects in materials and workmanship for the period of one year from receipt by buyer. In the event applicable law imposes any implied warranties, the implied warranty period is limited to 90 days from the date of receipt. Some jurisdictions do not allow such limitations on the duration of an implied warranty, so the above limitation may not apply to the buyer.

Other than as described here, there are no other expressed or implied warranties.

Customer Remedies

The Company’s and its suppliers’ entire liability and Customer’s exclusive remedy shall be the repair or replacement of the product that does not meet this Limited Warranty. This Limited Warranty is void if failure of the product has resulted from accident, abuse, modification, or misapplication of the product(s). Any replacement product will be warranted for the remainder of the original warranty period or 90 days, whichever is longer.

No Other Warranties

To the maximum extent permitted by applicable law, the Company and its suppliers disclaim all other warranties, either express or implied, including, but not limited to implied warranties of merchantability and fitness for a particular purpose. This limited warranty gives customer specific legal rights. Customer may have other rights depending on the jurisdiction.

No Liability for Damages

To the maximum extent permitted by applicable law, in no event shall the Company or its suppliers be liable for any damages whatsoever (including without limitation, special, incidental, consequential, or indirect damages for personal injury, loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use this product, even if the Company has been advised of the possibility of such damages. In any case, the Company’s and its suppliers’ entire liability under any provision of this agreement shall be limited to the amount actually paid by the buyer.

In addition, this warranty does not cover loss, damage, or defects that result from transportation to buyer, improper care by buyer, buyer-supplied software or other components, unauthorized changes, use, or misuse (including, but not limited to, use outside of the specified environmental conditions).

Product Service

Any claims of product failure of performance must be reported to Company within 30 days of product’s receipt by buyer. During this time, the buyer may return the product to Company for repair at Company’s cost and at no cost to the buyer.

The Company recognizes that expendable items may not function for the full year covered by this Limited Warranty. Expendable items, such as filaments, grids, special ceramics, and ionizers, are therefore excluded from the Limited Warranty for the specific product of which they are a part. However, each of these expendable items will have its own warranty and will be replaced or repaired in accordance with its warranty.

Buyers who purchased the product through one of the Company's international sales representatives should contact their sales representative to make arrangements for return, repair, or replacement.

IG2 Introduction

This manual provides information about the IG2 Ion Source Package, which comprises the Model 04-165 2 kV Backfill Ion Source and the Model 32-175 Ion Source Control, as well as additional options available for the IG2.

The RBD 04-165 Ion Source is interchangeable with the PHI® 04-161 and 04-162 ion sources. The RBD 32-175 Ion Source Control is interchangeable with the PHI® 20-045 control. As a result, the RBD Model 04-165 works with the PHI 20-045, and the PHI 04-161 and 04-162 ion sources work with the RBD Model 32-175. This manual discusses the options available for the IG2, the items required to use RBD's components with corresponding PHI components, as well as differences in operation or other aspects of a component's use.

RBD Model 04-165 2 kV Backfill Ion Source

The Model 04-165 2 kV Backfill Ion Source generates an energetic inert gas ion beam for sputter-etching solid surfaces. The source requires a static pressure of 5×10^{-5} torr with an inert gas such as argon. Ions are generated by electron impact within the ion source's dual filament ionization chamber and are then focused at the target with energies of up to 2K eV. The impurity content of the ion beam is minimized by using an off-axis filament geometry. A focusing lens permits high ion current density to be obtained for a given operating pressure and source-to-sample distance. A dual tungsten filament assembly permits continued operation when the first filament opens. The expected lifetime of the filament assembly is several years under normal usage at the recommended operating conditions. The filament assembly is easily replaced in the field.

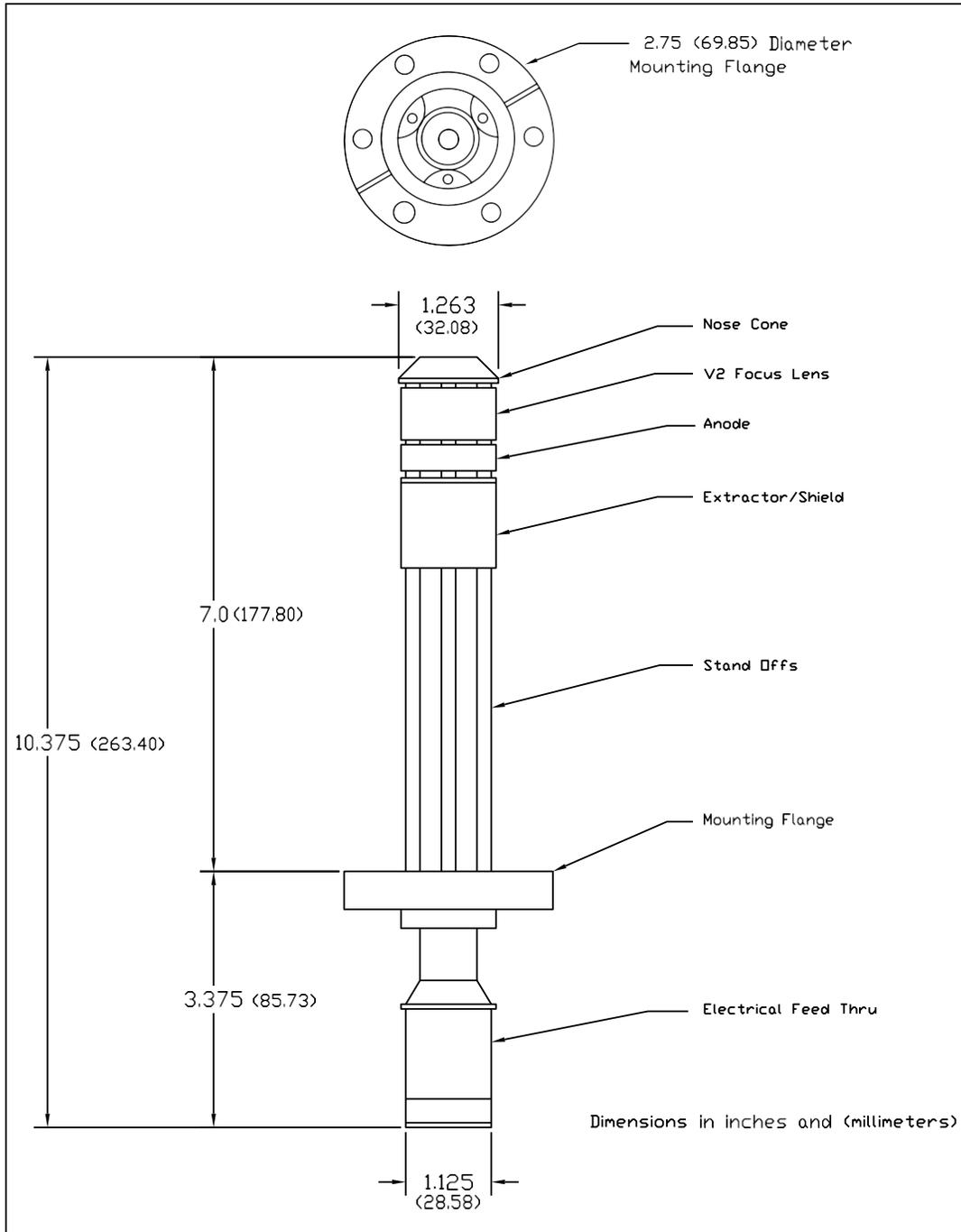
The 04-165 fits on a standard 2.75" flange, which has a 1.35" ID and a 1.5" OD.

04-165 Specifications

Specification	Description
Source Type	Hot filament electron impact (dual filament, backfill type)
Beam Energy	.5 kV to 2 kV
Minimum Beam Diameter	
» at 25 mm working distance	2.5 mm FWHM (at target)
» at 50 mm working distance	3.5 mm FWHM (at target)
Maximum Total Target Current	$\geq 10 \mu\text{A}$ at $V_B = 2 \text{ kV}$.
Maximum Current Density	
» at 25 mm working distance	$\geq 200 \mu\text{A}/\text{cm}^2$ when $V_B = 2 \text{ kV}$
» at 50 mm working distance	$\geq 100 \mu\text{A}/\text{cm}^2$ when $V_B = 2 \text{ kV}$
Mounting	Standard 2.75" CF bored flange OD, 1.35" ID minimum tube required
Flange to End of Optics	7.00" or 9.25" (2.25" less with optional x-y aligner)
Working Distance	Typically 50 mm end-of-optics-to-target

04-165 Diagram

The diagram below identifies the dimensions of the RBD 04-165 as well as its sections. Please note that the vertical dimensions reflect the 04-165 dimensions when the optional X-Y aligner (RBD part number IG2-EA) is not used.



Model 32-175 2 kV Ion Source Control

The Model 32-175 2 kV Ion Source Control provides all the necessary voltages and currents required to operate the Model 04-165 2 kV Backfill Ion Source or the PHI 04-161/162 ion sources. The beam voltage may be activated manually or remotely. The focus control allows the beam size to be varied, and can be externally calibrated to optimize current density. Anode current (ion current), filament current, beam and focus voltages all can be monitored to ensure accurate resetting of sputtering conditions.

32-175 Specifications

Specification	Description
Input Power	120 or 230 VAC @ 47-63 Hz, Single Phase
Output Voltage	.5 kV to 2 kV in 500 volt increments
Ripple-to-Noise	≤30 mV peak-to-peak
Focus Voltage	Variable, 0 to 100% of the Beam Voltage
Front Panel Controls	
» Beam Control	Manual (local), Remote
» Beam Voltage Control	4-position switch
» Focus Voltage Control	1-turn potentiometer
» Filament Current Control	10-turn potentiometer
Remote Input (on Back Panel); BNC-type connector	Beam Voltage ON/OFF; TTL Low = ON
Filament Current Limit	2.5 A
Filament Voltage	Nominally 8 V at 1.7 A
Front Panel Emission Current Monitor	Nominally 25 mA
Cooling	Convection and cooling fan
Dimensions	19" rack mount x 14" deep x 3" high

Unpacking the IG2

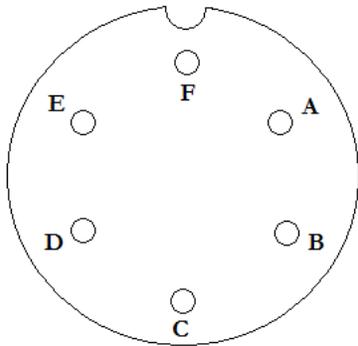
1. Inspect the boxes for any visible damage. If there is any damage, please report it to the shipping company immediately.
2. Remove all components and inspect them for damage. If there is any damage, please report it to the shipping company immediately.
3. Verify that you have the following items. If any are missing, please contact RBD Instruments at 541-330-0723 or e-mail us at tech@rbdinstruments.com.
 - 04-165 Ion Source
 - 32-175 Control
 - IG2-CA1 Cable
 - AC Power Cord
 - IG2 Manual (also available at <https://rbdinstruments.com/products/files/ig2-manual.pdf>)

Setting up the IG2

Install the 04-165 Ion Source

1. Perform a resistance check of the 04-165.
 - a. Using an ohm meter, measure the resistance of the pins on the 04-165 ion source.
 - b. The filament pins (A to B and B to C) should show less than 1 ohm of resistance.
 - c. All other pins should be open to each other.
 - d. All pins should be open to ground (the outside of the 04-165 electrical connector).

04-165 ion source connector as viewed from end of source



Pins A to B and pins B to C should have less than one ohm of resistance
All other pins should be open to each other
All pins should be open to ground

Pin	Description
A	Filament 1
B	Filament Com
C	Filament 2
D	Focus
E	Grid Voltage
F	Ext. Voltage

2. Remove the blank flange from the vacuum chamber port into which you are installing the ion source.
3. Insert a new copper gasket between the ion source and the flange.
4. Tighten the ion source flange using the appropriate hardware.
5. Bake the system at 150° C to 200° C for 4 to 8 hours. You may use heat tape to bake only the 04-165.

Install the 32-175 Ion Source Control

1. Mount the 32-175 Control in a 19" electronics rack or use on a desktop (ensure power cable is disconnected and power switch is off).
2. Connect the 04-165 Ion Source to the 32-175 Control using the IG2-CA1 cable.
3. Connect the AC power cord (120 VAC OR 230 VAC) to the 32-175 and then plug the AC power cord into the power outlet. **DO NOT TURN ON THE POWER to the 32-175 at this time.***
4. Set the following switches and controls on the 32-175 Control front panel:
 - a. Set the Beam Control switch to Off.
 - b. Set the Beam Voltage Select dial to 500, which is its lowest setting.
 - c. Turn the Focus Adjust dial arrow to center (straight up).
 - d. Turn the Filament Adjust dial fully counterclockwise (set to 0).
5. On the 32-175 Control back panel, set the Filament Select Switch (labeled F1 and F2) to the F1 position.
6. **The IG2 is now ready for use.**

**** It is recommended that the AC power to the 32-175 is interlocked to your ion gauge so that the 32-175 cannot be turned on if your vacuum chamber is up to air.***

Remote Switching of the Ion Beam

If you want to use a computer to control the ion beam remotely, you need to connect a TTL level BNC cable to the Remote connector on the back of the 32-175. A TTL **low** turns the beam voltage **ON**, and a TTL **high** will turn the beam voltage **OFF**. The Remote signal only turns the beam voltage on and off. The filament is controlled independently.

Operating the IG2 With the 32-175 Controller

32-175 Front Panel Controls and Meter

- **Main power ON / OFF:** Turns the 32-175 ON and OFF
- **Beam voltage ON / OFF / Remote Switch:** Turns the beam voltage ON, OFF and on and off remotely. *In the remote mode TTL low (or shorted relay contacts) = Beam ON*
- **Beam Voltage Knob:** Sets the Beam Voltage to 500, 1000, 1500, or 2000 volts DC. The Beam voltage accelerates the ions to the target.
- **Focus:** Adjusts the size of the ion beam.
- **Emission Potentiometer:** Sets the filament current, resulting emission current is displayed on the emission meter.
- **Emission Meter:** Displays the emission current, 25mA nominal.

Initial Out-gassing of the 04-165 Ion Source

IG2 packages and 04-165 Ion Sources newly purchased from RBD have had initial outgassing procedure performed. If the 04-165 Ion Source is up-to-air for an extended period of time after initial outgassing, follow the outgassing procedure, noting that wait times may be reduced by 50%.

NOTE: Before outgassing the 04-165 ion source the vacuum chamber needs to be baked out to remove water vapor from the ion source.

If at any time during out-gassing the emission meter starts to climb rapidly, turn the Emission Potentiometer down until the emission current stabilizes. Then resume the procedure.

1. With the 32-175 main power switch OFF, make sure that the Emission Potentiometer is fully CCW. The Emission Potentiometer controls the filament current. 0 to 10 turns corresponds to 0 to 2.0 amps of filament current.
2. Set the Beam Voltage Knob to 500 V and the Beam Voltage Switch to OFF.
3. Turn the 32-175 main power switch ON.
4. Slowly turn the Emission Potentiometer CW typically 6 to 7 turns until you have 1 to 2 mA of emission current. Keep turning the potentiometer until the emission activates. **Watch the meter – if it spikes, turn down immediately until you are back between 1 and 2 mA.**
5. Wait for 10 to 20 minutes then turn the Emission Potentiometer CW until you have 5 mA of emission current.
6. Wait 10 to 20 minutes and then increase the Emission Potentiometer until you have 10 mA of emission current.

7. Repeat this process in increments of 5 mA until you have 25 mA of emission current.
8. With the emission current still at 25 mA and the Beam voltage set to 500 V, turn the beam voltage ON.
9. Wait 5 minutes and then turn the beam voltage to 1000V.
10. Wait 5 minutes and turn the beam voltage to 1500V.
11. Wait 5 minutes and turn the beam voltage to 2000V.
12. Turn the beam voltage OFF.
13. Turn the emission current knob fully CCW.
14. Repeat steps 2-13 for filament F2.
15. Turn off the 32-175 main power.

The 32-175 and 04-165 ion source are now ready to operate using filament F1 or F2.

Operation of the 32-175 Control and 04-165 Ion Source

1. Make sure that the emission current knob is fully CCW.
2. Set the beam voltage to OFF.
3. Turn the emission current knob CW 6 to 7 turns until there is 1 to 2 mA of emission current.
4. Let the emission current stabilize for a minute then slowly increase the emission current knob until there is 25 mA of emission current.
5. Back-fill the chamber with Argon to 5 to 6 X 10⁻⁵ Torr.
6. Set the beam voltage knob to the desired acceleration voltage (typically 2000V).
7. When you turn the beam voltage to ON the 04-165 source will be sputtering the sample.

Optimizing the Ion Beam Diameter (Focus)

Method 1 - Measure the Target Current:

Using a picoammeter with a +90 V bias to measure the target current. Adjust the Focus knob on the 32-175 to maximize the target current (typically 5 μ A). The maximum current corresponds to the highest current density (smallest beam diameter).

Method 2 – Focus on a Phosphor Sample:

Insert a phosphor sample with a fine mesh over the surface to prevent charging on the phosphor sample. When the beam voltage is turned on the phosphor will illuminate. Adjust the 32-175 Focus knob for the smallest beam looking at the ion induced illumination. You can also use this method to de-focus the ion beam to sputter over a larger area. The current density will drop when the ion beam is defocused.

Using the 04-165 with a PHI 20-045 Control

When you use the RBD 04-165 with a PHI 20-045 control, the 20-045 should be operated at 10 mA of emission current, not 25 mA as with the 04-161/162. The ionizer in the 04-165 is more efficient, so operating it above 10 mA will shorten the filament lifetime.

Using the 32-175 with a PHI 04-161 or PHI 04-162 Ion Source

The 32-15 is used with the 04-161 or 04-162 in the same way it is used with the RBD 04-165.

IG2-EAPR Equipment Aligner

The IG2-EAPR Equipment Aligner provides the ability to adjust the X-Y alignment of UHV optics components that are mounted on a 2.75-inch CF flange. The IG2-EAPR increases the end-of-optics to target distance by 2.25 inches. Note that the IG2-EAPR requires a large ID tube (approximately 1.5") to work properly.

The IG2-EAPR flange, which is tapped for six ¼"-28 mounting bolts, is mounted to the vacuum chamber at the appropriate 2.75-inch CF flange on the chamber using a 2.75" **large ID** gasket. The optics unit is then mounted to the aligner with its own flange using a 2.75" **standard** gasket. The X-Y adjustment is then accomplished by adjusting the four thumb screws located around the sides at the top of the IG2- EAPR.

The IG2-EAPR is UHV compatible and fully bakeable to 200° C.

Cables to Connect RBD and PHI Components

The following cables are required for the connections indicated. (Note that if you are connecting the RBD 04-165 and the RBD 32-175, you use the IG2-CA1 cable that is included with your IG2 package).

Between These Components	RBD Part Number
RBD 32-175 and PHI 04-161/04-162	IG2-CA2
RBD 04-165 and PHI 20-045	IG2-CA3

Principles of Operation

The RBD Model 04-165 2 kV Backfill Ion Source is used with the RBD Model 32-175 Ion Source Control. Together with the appropriate gas admission system such as the RBD IG2-AGA, these units comprise a complete system designed to sputter-etch a specimen surface using inert-gas ions. The ion source is CF flange mounted and can be installed in standard vacuum systems. The control unit contains all the electronics and power supplies necessary for operating the ion source.

The Model RBD Model 04-165 2 kV Backfill Ion Source generates an energetic inert-gas ion beam for sputter-etching solid surfaces. In operation, the test chamber is backfilled to a static pressure of 5×10^{-5} torr with an inert gas such as argon. Positive ions are created by electron impact within the ion source's ionization chamber. The ions are then extracted from the ionization chamber, accelerated through a focusing lens, and directed at a specimen with energies up to 2 keV. The impurity content of the ion beam is minimized because there is no direct line of sight from the hot filament to the target. Operating parameters are adjustable on the front panel of the Model 32-175 Ion Source Control. Focus, beam voltage selection, filament selection, and emission are all controlled by the ion source control.

Appendix – Cable Diagrams

The cable diagram for the cable included with the IG2 is provided in this appendix. We have also included cable diagrams for the optional cables that are available to integrate the RBD 04-165 ion source with the PHI controller and the RBD 32-175 ion source control with the PHI ion sources.

IG2 Cable #1 (IG2-CA1-A)

7-Pin Amphenol Connector
Cable Clamp and Rubber bushings

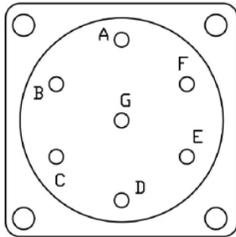
Lapp/USA
7-Conductor, 20 Awg.
Cable Length = 15'

6-Socket Amphenol Connector
Cable Clamp and Rubber bushings

Filament 1	A
Filament Com.	B
Filament 2	C
Focus	D
Grid Voltage	E
Ext. Voltage	F
NC	G

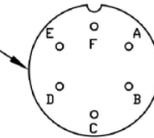


A	Filament 1
B	Filament Com.
C	Filament 2
D	Focus
E	Grid Voltage
F	Ext. Voltage



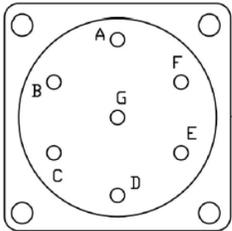
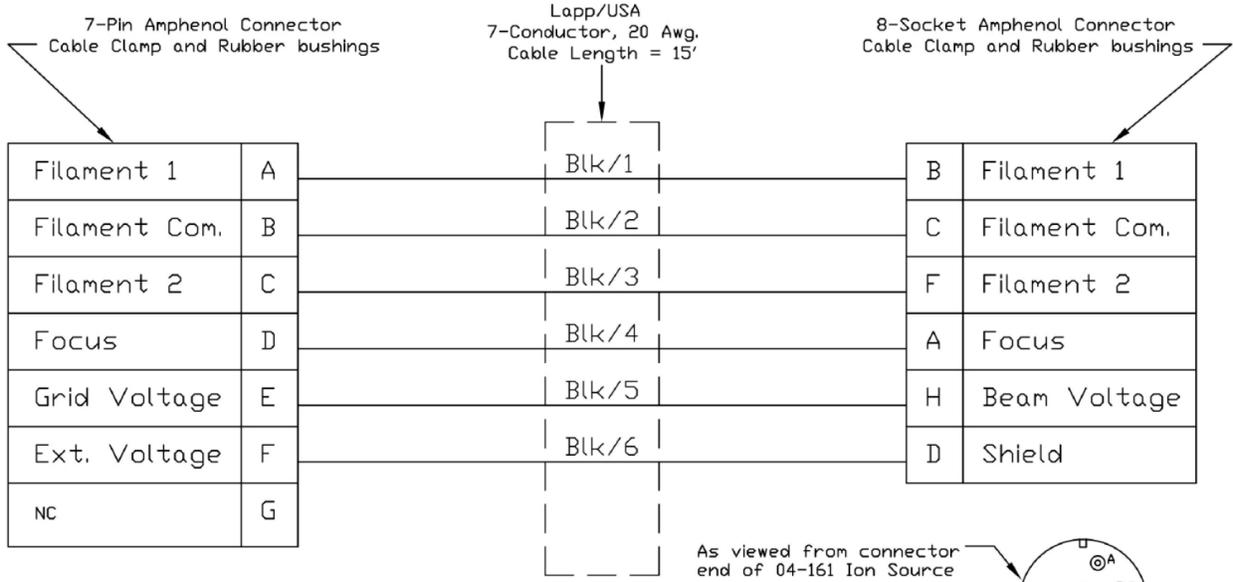
As viewed from rear of
32-165/175 Controller.

As viewed from connector
end of 04-165 Ion Gun.



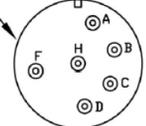
DRN. R. Chase	DATE 8/20/07	RBD Instruments 2437 NE Twin Knolls Drive Bend, Oregon	
<small>This drawing contains proprietary information and any reproduction, disclosure or use of this drawing is expressly prohibited except as RBD Enterprises may otherwise agree to in writing.</small>		Title IG2 Cable 1 RBD 32-165/175 to RBD 04-165	
		DRAWING NO. IG2-CA1-A	REV. A
		SIZE A	SHEET 1 OF 1

IG2 Cable #2 (IG2-CA2-A)



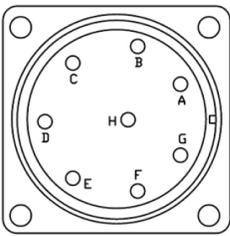
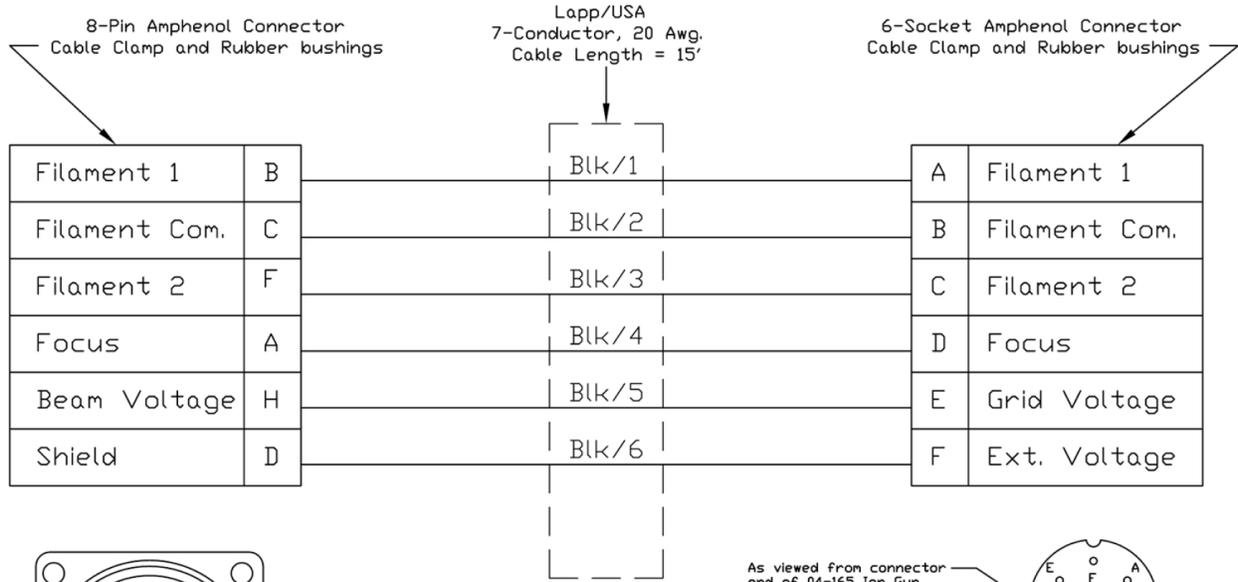
As viewed from rear of
32-165/175 Controller.

As viewed from connector
end of 04-161 Ion Source

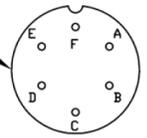


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		DRAWING NO. IG2-CA2-A	REV. A
SIZE A	SHEET 1	OF 1	

IG2 Cable #3 (IG2-CA3-A)



As viewed from rear of 20-045 Controller



As viewed from connector end of 04-165 Ion Gun.

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		DRAWING NO. IG2-CA3-A	REV. A
		SIZE A	SHEET 1 OF 1