3 l/s (4E3L) MODION®

3 l/s Modular Ion Pump Systems
Instruction Manual

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MODION®

MODION® compact modular ion pump systems are offered with several connection styles to choose from. Straight or right angle inlet orientations are available. This instruction manual covers our commercial pumps. For custom pumps and power supplies, please contact the MODION® team at MODION® Inc. for more information.

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1.0 DESCRIPTION OF MODION® PUMP AND GAUGE

This small, lightweight, portable ion pump/gauge unit represents a new approach to the familiar appendage pump. Its compact design allows the high voltage modular power supply, ion pump, and the display module to be assembled into a single inter-connected unit with a mass from 318gm to 360gm and less than 5 inches in overall length. A four decade, easy to read bar graph meter display and a 0-5VDC analog signal continuously monitors the level of vacuum within the pump.

The MODION® Pump/Gauge may be operated from several power sources for fixed or portable operation:

A. The standard Model 110/220VAC switchable wall adapter, with C-1766Q modular power supply.

B. The pump portion of MODION® modular ion pumps may be operated remotely via HV cable from MODION®'s HVPS R-1800 (high voltage power supply).

C. Operation from Auxiliary batteries (12VDC) with C-1766 modular power supply to provide backup or portable operation. This mode can permit complete portability during processing, storage and shipping of a user's vacuum device

D. Operation from MODION® BB3S Battery Pack with C-1766 modular power supply. The battery pack is designed to run small modular MODION® systems for 2-3 days. The BB3S can also be used as an Uninterrupted Power Supply (UPS) in case of sudden power failure. The BB3S is covered by our 1 year limited warranty when used with MODION® modular ion pumps.

The two basic modules of the MODION® unit are readily separated to permit UHV bake out of the pump unit at termperatures up to 350C. For ultra-high vacuum applications, bake out is essential to insure pump cleanliness and performance. High energy rare earth magnets greatly reduce the MODION's® size, weight and stray magnetic field. **THESE MAGNETS MUST BE REMOVED PRIOR TO ANY BAKE OUT ABOVE 100C.**

Please read the instructions to familiarize yourself with the other features of the MODION® system and its care and use.

WARNING!



HAZARDOUS VOLTAGE CAN CAUSE SEVERE INJURY OR DEATH

BEFORE ASSEMBLY OR DISASSEMBLY OF MODULES

- READ AND UNDERSTAND THIS ENTIRE MANUAL
- TURN POWER OFF
- BE SURE ENTIRE SYSTEM IS GROUNDED PRIOR TO INTRODUCING POWER

2.0 INSTALLATION AND USE

2.1 Application and Installation

(Pump)
The modular ion pump and its electronics module are packaged assembled. The pump/gauge unit (with magnets) is pumped down during bake-out, and remains in high vacuum condition during shipment. Each MODION® should remain sealed until the time of installation on the customer's device to preserve maximum cleanliness of the internal cathodes.
Each unit undergoes inspection and testing during each phase of manufacturing, and is leak tested prior to shipment.

The MODION® when used in its pumping mode, is intended for use as an appendage pump for UHV systems applications requiring continuous pumping of self-outgassing products. The MODION® requires an oil-free, clean high vacuum to reach its starting pressure of approximately $1x10^{-4}$ Torr. (A turbo-molecular pump, cryogenic pump, auxiliary ion pump, or a well-trapped oil diffusion pump is sufficient for this purpose.) Although the MODION® operates at pressures more than a decade above its maximum ($1x10^{-5}$ Torr), when used with the modular power supply, the flashing bar graph display reminds that the pump's speed is lower than normal, and auxiliary pumping is necessary for efficient evacuation of the user's volume. Bake out of any high vacuum system is recommended to reduce outgassing and to achieve rated pumping speeds.

MODION® ion pumps are available with a variety of tubulation sizes of flanges. If the tubulation is to be brazed/flared to the user equipment, care must be taken to pack it full with dry nitrogen to keep the unit clean and free of oxides. **DO NOT HYDROGEN BRAZE—THIS PROCESS WILL DESTROY THE CATHODE'S PUMPING ABILITY.** Any mating connections should also be prepared before the shipping flange is removed from the MODION® pump. The MODION® may be mounted in any convenient location and orientation. Please read and understand all instructions prior to installing or using the MODION®.

When installing flanged units, always use clean, new copper gaskets of a type recommended by the flange manufacturer. Handle gaskets only at the edges. Use washer under flange nuts and apply molybdenum disulfide lubricant to all bolt threads. Use a torque wrench to tighten bolts evenly to 8 ft/lbs.

In the interest of good vacuum practice and to realize potential pumping speeds, keep tubulation as short as possible. If your MODION® unit has a mesh screen inside the conflat-style flange, do not remove this screen.

IMPORTANT: TO INSURE ELECTRICAL SAFETY, THE MODION® BODY MUST BE AT LOCAL ELECTRICAL GROUND POTENTIAL. WHEN MOUNTED TO A METAL VACUUM SYSTEM, MAKE SURE THE MOUNTING SURFACES ARE TRULY GROUNDED. WHEN MOUNTING TO A GLASS OR OTHER NON-CONDUCTING VACUUM SYSTEM, A SEPARATE GROUNDED LEAD MUST BE CONNECTED SECURELY TO THE MODION®.

2.2 DISASSEMBLY OF MODION® FOR BAKEOUT.

3 l/s MODION®

1. Make certain that no input power is connected to the MODION®
2. Remove four (4) screws (1 on each side) at base of power supply.
3. Gently remove power supply from pump
4. Remove two (2) lock nuts from aluminum adapter plate.
5. Remove plate from pump
6. Remove two (2) acorn nuts from magnet return yoke
7. Remove yoke, magnets, and magnet pole pieces from pump

Note: ion pumps should be under vacuum (at least 10^{-4} torr) during bakeout.

2.3 ASSEMBLY OF MODION® AFTER BAKEOUT

Assembly will be the reverse of disassembly instructions.
Note: make certain all mounting screws are secure to insure proper grounding of the power supply. If proper grounding is not present, a shock hazard may exist.

2.4 CONNECTING POWER SUPPLY

Make sure the MODION® power supply is assembled and grounded to pump. Plug the small cable connector found on the "wall adapter" into the mating socket on the modular power supply. The MODION® system is now ready for operation. The automatic switching wall adapter can accommodate input power from 100 to 240V—50/60Hz.

2.5 MODULAR POWER SUPPLY UNIT CHARACTERISTICS

The MODION® electronics are specifically designed to limit the current to the pump unit to safe values at operating pressures above 10^{-5} Torr, and also limit current drain during off-scale pressure conditions. This modular power supply unit may be operated at ambient temperatures from 0 to 60C.

2.6 BAR GRAPH DISPLAY

When the MODION® pump power is first turned on, the entire bar graph display may flash repetitively. This condition is normal and is attendant upon the start-up of the discharge within the pump. If the condition persists, a leak or internal outgassing of the user device may be indicated. If no leaks are found using a Mass Spectrometer Leak Detector (MSLD), further external pumping or bake out of the system may be required. The MODION® modular power supply unit has a series impedance which causes the pump high voltage to markedly decrease at pressures above 10^{-5} Torr. This restriction protects the titanium cathode from overheating (due to the excessive dissipation when the pump is operated at higher pressures), however it also significantly reduces the pump's efficiency.

As pump pressure decreases, the bar graph display will cease flashing and the bars will fade out one after another. If greater pressure resolution is desired, the 0-5 volt analog output may be monitored. The chart supplied (*Figure 2)* may be used to translate the voltage readings to vacuum pressure. (Use a high impedance voltmeter to measure this voltage). It may prove desirable to produce your own precise calibration of the analog output signal.

If all bar segments are out, the pump pressure is below 10^{-8} Torr. Be sure the "power on" LED indicator is lit (see Figure 1).

Similarly, operation of the pump discharge may be confirmed for pressures above 10^{-5} Torr (off scale reading of the bar graph display) by monitoring the analog output. The analog voltage will rise above 5 volts for pressures greater than 10^{-5} Torr until a level of 9-10 volts is reached. (The discharge cannot be sustained when internal pressures are greater than approximately 10^{-3} Torr).

3.0 OTHER OPERATING MODES

3.1 MODION® BB3S BATTERY BACKUP/UPS

The MODION® BB3S Battery Backup/Uninterrupted Power Supply can be purchased to supply power any small modular MODION® system from up to 3l/s pumping speed. Run time is between 2-3 days, depending on pressure and bar graph operation. Please see www.modionvacuum.com for more information about the MODION® BB3S Battery Backup.

3.2 AUXILIARY BATTERY OPERATION

The MODION® system may be operated from a 12 volt battery for both backup or portable use. Separate battery inputs are provided to enable powering only the high voltage modular power supply for those times when the LED display is not required. This provides maximum battery life for the pumping function. When an LED pressure display is desired, the battery can be connected to power the display while readings are taken and then disconnected to minimize battery drain.

Connections for battery operation are made to the “free leads” on the cable connector plugged into the modular power supply. These connections are:

Battery Common (Negative) ———— *BLACK*

High Voltage Supply only (+VDC) —— *ORANGE*

Display Supply (+12 VDC) ———— *RED*
(Battery Common is at Ground Potentials)

For continuous display, tie the red or orange leads together.

3.3 ANALOG OUTPUT SIGNAL

A 0-5 volt analog output signal is available from the modular power supply. This signal can be used to drive remote indicators or chart recorders and generate calibration, resolution, or a permanent record of system pressure. Connections for this signal are made to the “free leads” on the cable connector plugged into the modular power supply. These connections are:

Common (ground potential) ———— Black
Analog Output ———————— Blue

3.4 EXTERNAL HIGH VOLTAGE SUPPLY

MODION® Inc. manufactures a High Voltage Power Supply (HVPS) that can be purchased separately to operate our pumps remotely. The HVPS is used in place of the modular power supply. Please see www.modionvacuum.com for more information about the HVPS R-1800 Remote Power Supply

3.5 HUMID & HIGH VACUUM ENVIRONMENTS

The MODION® system itself may be operated successfully in a humid or vacuum ambient environment without threat of high voltage breakdown at critical pressures, if the volume around the HV connection is carefully packed with clean silicone high voltage grease before the pump/power supply are assembled together. Make certain air voids are not left in this insulating packing by applying sufficient material to fill the cavity.

3.6 SUGGESTED BAKE OUT PROCEDURE

Remove the following MODION® components prior to bake out of the pump unit.

Power Supply

Magnets & Their Return Yoke

(Handle the magnets with care; they will be chipped or broken by sudden attraction to each other or to iron objects.)

During bake out of the pump unit, monitor pump body temperature to avoid overheating. After bakeout and cool down, re-install the magnets and magnet yokes onto the pump unit, while making sure to observing magnet polarity.

Assemble the Power Supply unit to the pump (as described previously). Make sure that all fasteners are in place and tight to insure proper grounding.

4.0 THEORY OF OPERATION

The MODION® ion pump utilizes the familiar Penning discharge to ionize the residual gas molecules inside the pump. The magnetic field confines the discharge to a small volume within the pump, and increases the efficiency of pumping by greatly increasing the number of collisions with electrons generated by the ionization process. Thus, a relatively dense cloud of spiraling electrons is formed within the discharge to ionize gas molecules more efficiently. The process is self-regulating so that the discharge does not go from Townsend to ARC. The ions formed are accelerated to the cathodes (titanium) where they impact with sufficient energy to become entrapped. This process, called "sputtering", creates a continuously renewed surface of pure titanium molecules, which accomplish the active pumping.

A clean titanium surface has a high chemical attraction (affinity for almost all chemically active gases (H2, N2, O2, etc.) When an active gas molecule strikes the fresh titanium surface, it is bound to that surface by strong chemical bonds. These gases are in effect, "pumped" by the titanium surface. The sputtering process also effectively buries gas molecules under layers of fresh titanium as the process continues over a long period of time.

The Inert gases (He, Ar, Kr, Xe) have little affinity for titanium, and these gases are held weakly to the surface by ionic bonds. The probability of these gas molecules adhering to the titanium surface is low, and the binding forces are much weaker than for other gases.

The "pumping" action of a titanium film surface can also be affected by ion bombardment at the cathodes. High energy ions striking the cathode not only sputter fresh titanium, but will release a small number of previously pumped molecules as well. For this reason one often observes an initial rise in pressure when the pump is first activated.

For the inert gases, a re-emission rate is more pronounced (particularly for argon which constitutes nearly 1% of the earth's atmosphere by volume). The repetitive cycling from atmosphere to high vacuum tends to produce an argon-enriched background which must be removed to produce higher vacuum in the pump and in the user's volume. Best pumping performance results from prolonged bake out at high temperatures (350C if possible) using an auxiliary UHV pumping means. The MODION® pump is well suited for repetitive bake out at temperatures up to 350C.

Note: Be sure to remove power supply, adapters, magnets, and return yokes prior to bake out.

5.0 TROUBLESHOOTING, MAINTENANCE, AND SERVICE

CAUTION: HIGH VOLTAGE

DISCONNECT ALL INPUT POWER BEFORE SERVICING, THEN WAIT 30 SECONDS FOR POWER SUPPLY CAPACITORS TO DISCHARGE.

All troubleshooting, service, and inspection should be performed by qualified individuals only.

Troubleshooting:

PROBLEM: Failure to start (no display or analog output) at pressures known to be within the normal operating range of the MODION® ion pump.

Perform the following checks to determine the cause:

1. Check to make sure the power supply "POWER ON" lamp is lit. If this lamp is not lit, check the wall adapter power supply by substitution or by observing 14-20VDC across pins 2 and 3 of this unit's cable connector.
2. Tap pump body gently with small non-magnetic metal tool. Dislocating of surface gas molecules will cause initiation of discharge.
3. Check to see if magnet yokes are installed with no air gaps at yoke joints, and with proper magnet polarity. (north and south should be "looking" at one another).
4. Disconnect input power from Power Supply and remove this unit from the pump unit. Bench test the Power Supply to confirm the presence of +3500 VDC (+/- 20%) at the female contact in the center of the "open" end of the unit. This voltage should be measured with respect to the metal housing of the unit. Use the wall adapter to energize the power source for this test. An appropriate high voltage meter or probe should be used to make this measurement. Exercise extreme caution when making this measurement to avoid electrical shock. THIS TEST SHOULD ONLY BE ATTEMPTED BY QUALIFIED PERSONNEL!
5. Inspect the pump's anode insulator (power supply removed). Measure insulation resistance with a high impedance ohmmeter capable of measuring resistances greater than 100 megohms. If resistance is below 10 megohms, there is leakage across the anode insulator. Wipe ceramic clean and dry, and retest.

PROBLEM: Gauge behaves erratically.

1. Disconnect input power and then remove power supply from pump unit. Check for presence of dirt or dust inside the "open" end of this unit and clean as required.
2. Bench test power supply as described previously. The bar graph display and analog output should indicate near zero when the power supply is unloaded.
3. Replace the power supply onto the pump unit and operate the MODION® system. If readings are still erratic, remove the magnets from the pump unit. If the display or analog output does not decrease, leakage across the anode insulator is indicated. Clean the insulator and recheck.

- If these simple troubleshooting measures do not solve the apparent problem, please contact MODION® Inc. at support@modionvacuum.com or 724.523.9610. Please include a description of your observations.

MAINTENANCE AND SERVICING

Because the MODION® pump power supply is encapsulated, all servicing on this unit must be done by the manufacturer.

The pump unit requires little or no maintenance. Approximate life is 20,000 hours when operated at 10^{-6} Torr or lower pressures.

Whenever the pump unit is temporarily removed from the vacuum system, it should be stored in a clean, dry vacuum. It is important that the following points be followed before placing the unit in service again (flange mounted units).

1. Inspect the UHV mounting flange for nicks, scratches, and other defects along with the knife edge seal.
2. Inspect and clean the mouth of the flange with appropritate solvent to remove debris, oil, deposits, and other foreign material.
3. Make sure all power supply to pump fasteners are present and tight to avoid a possible shock hazard.

6.0 SPECIFICATIONS

1. Pump Unit Applied Voltage ——————— +3500 VDC typical

   Maximum Bake Out Temp ——————— 350C when protected against atmospheric oxidation of seals

2. Modular Power Supply

   Normal Input Voltage (Pin 3) ——————— +14 to +20VDC (reverse polarity protected).

   Return ——————————————— (-) (Pin 2)

   Input Current ——————————————— 40 to 200 madc.(see note 1)

   Output Voltage to Pump ——————————— +3500VDC +/- 20%

   Case and Pin 2 ——————————————— (Return) At Ground Potential

   Battery Input (Pin 1 power supply) ——————— 12 VDC +/-5% (reverse polarity protected)

   (Pin 5 Display)

   (Pin 2 Return)

   Power Consumptioin in Battery Operation Mode: .5 to 2.4 watts depending on pressure and display operation.

   Operating Temperature Range ——————— 0C to 60C

   Note 1: Input current varies over pressure range; ex.200 ma at high pressure; 40 ma at lowest pressure. For maximum battery life, allow the unit to reach minimum pressure before switch over to battery operation.

SPECIFICATIONS (continued)

3. **3l/s MODION®**

   Pump mass ——————————120gm

   Power supply mass ——————240gm

   Dimensions ——————————See Figures 3-10

FIGURE 1

PINOUT AND DISPLAY

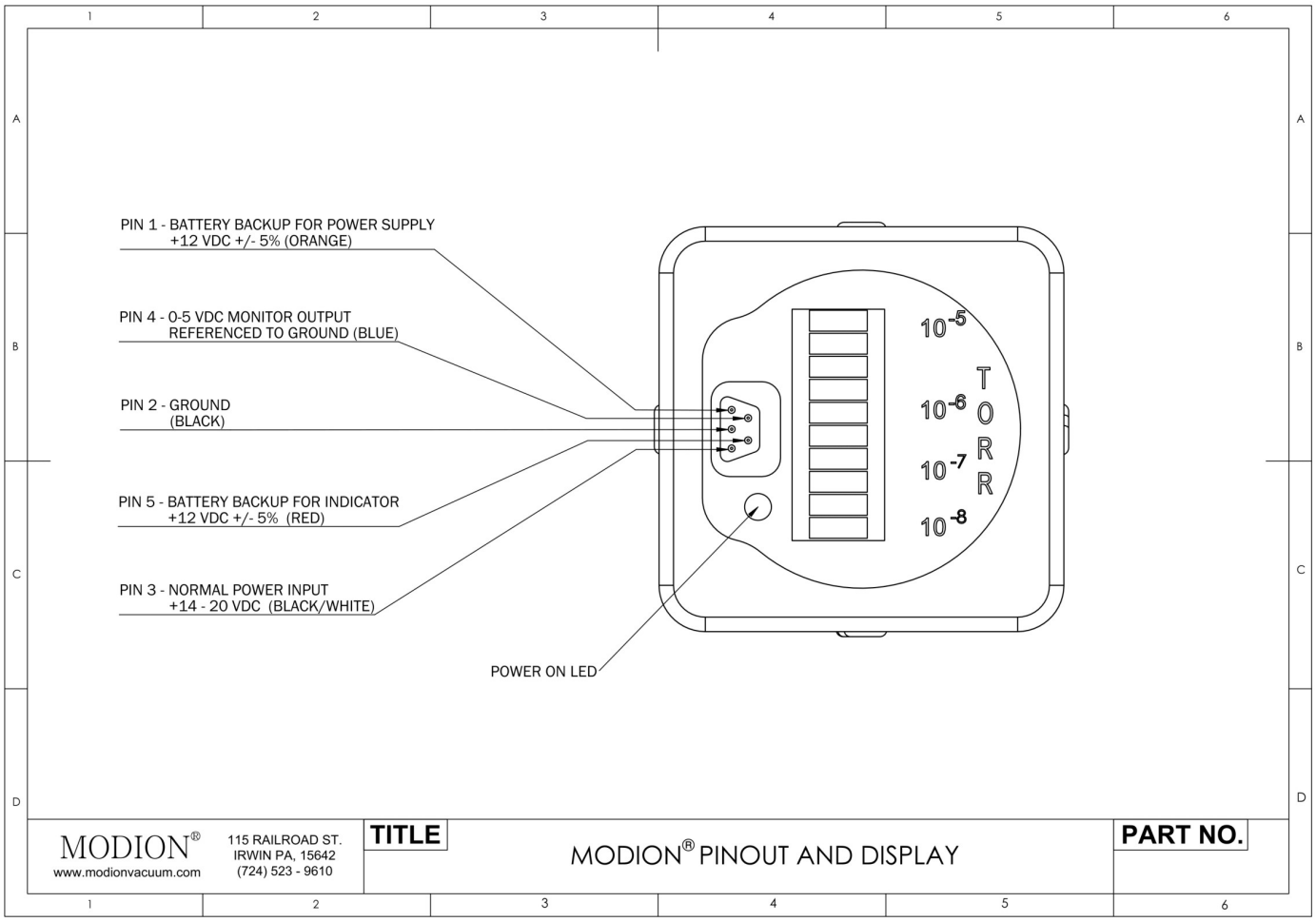


FIGURE 2

VOLTAGE VS. PRESSURE

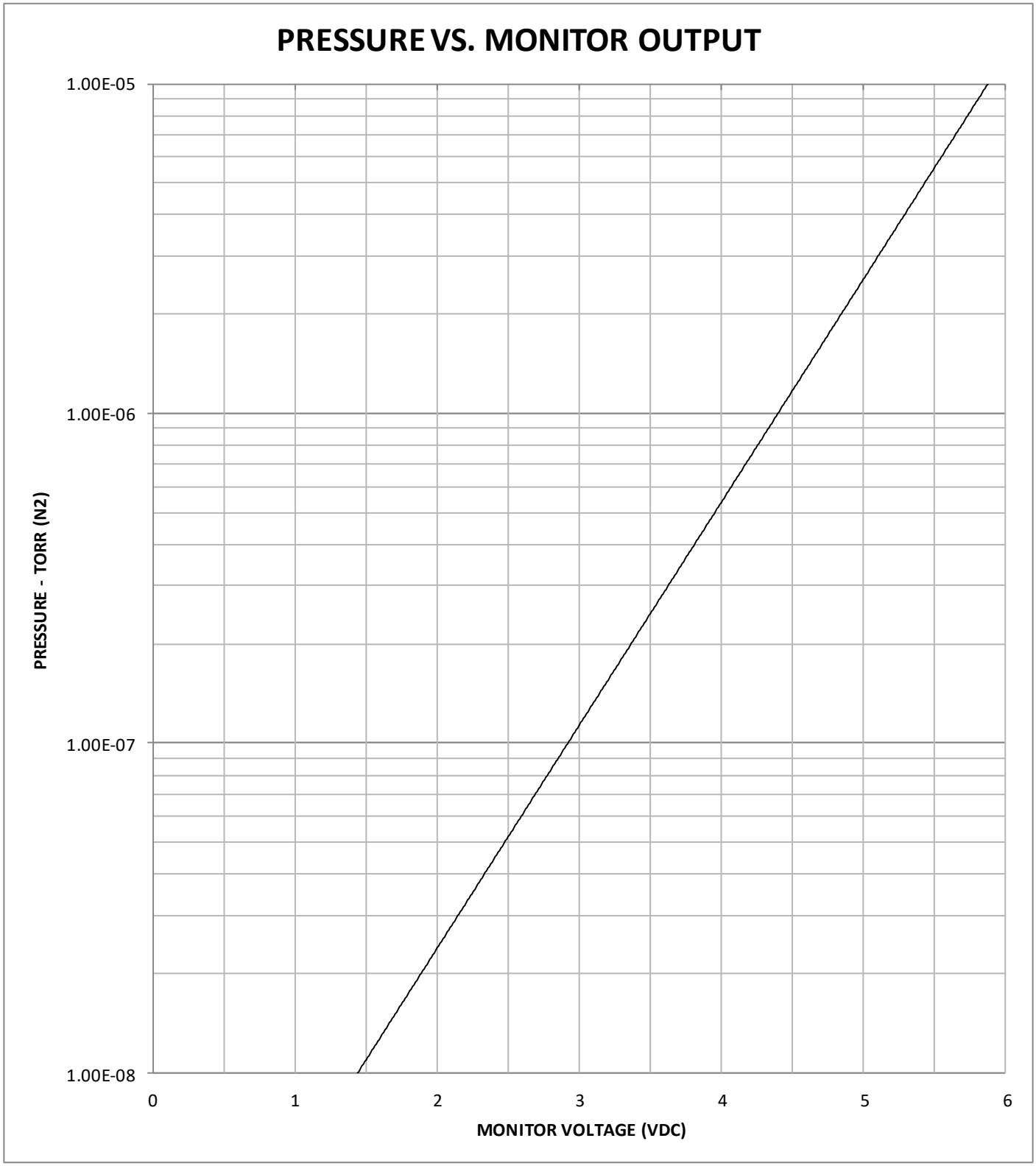


FIGURE 3

4E3LJAS 3 l/s Straight Orientation JBA Feedthrough

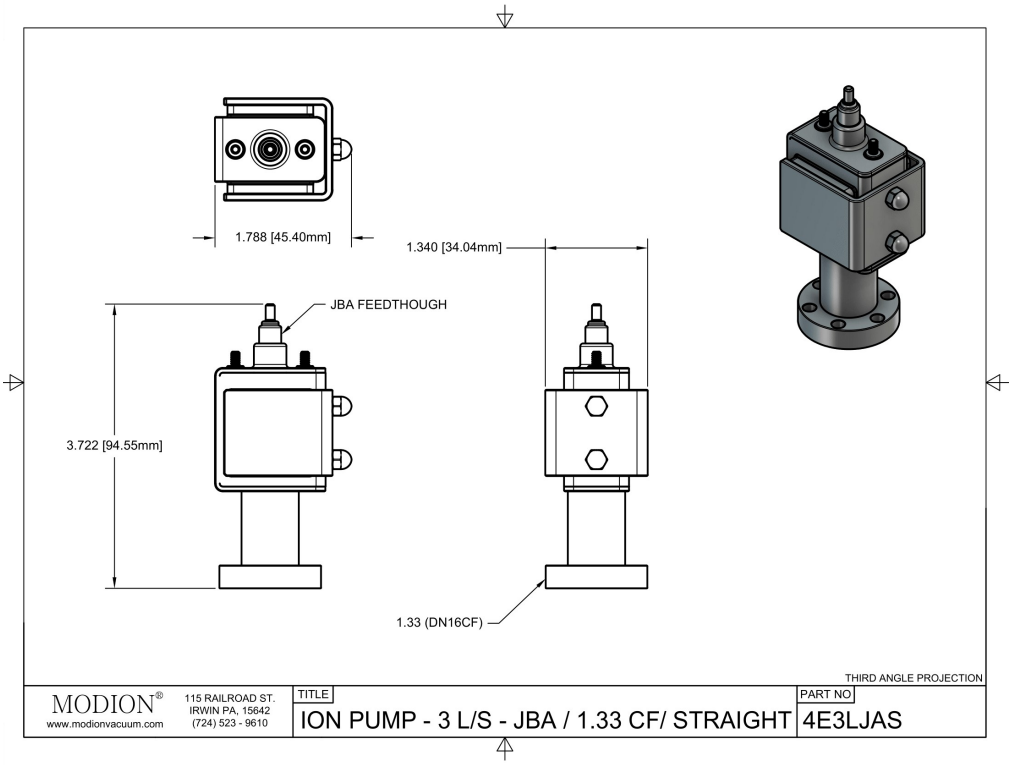


FIGURE 4

PK4E3LJAS-1766 3 l/s Package Straight Orientation JBA Feedthrough

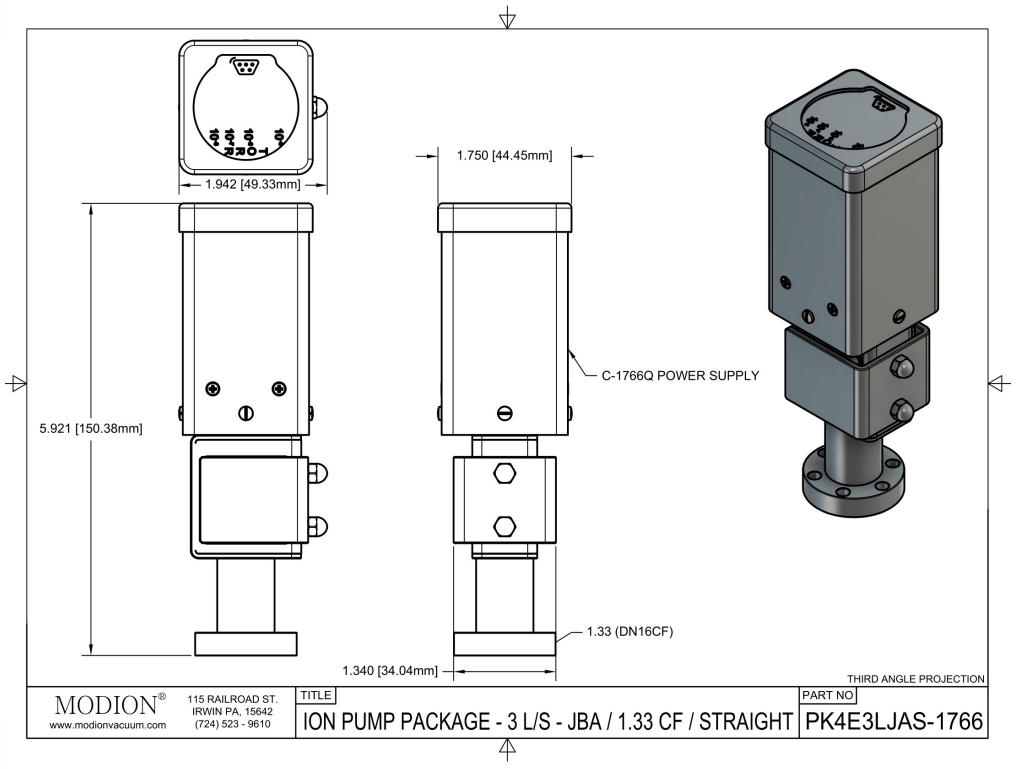


FIGURE 5

4E3LJAR 3 l/s Right Orientation JBA Feedthrough

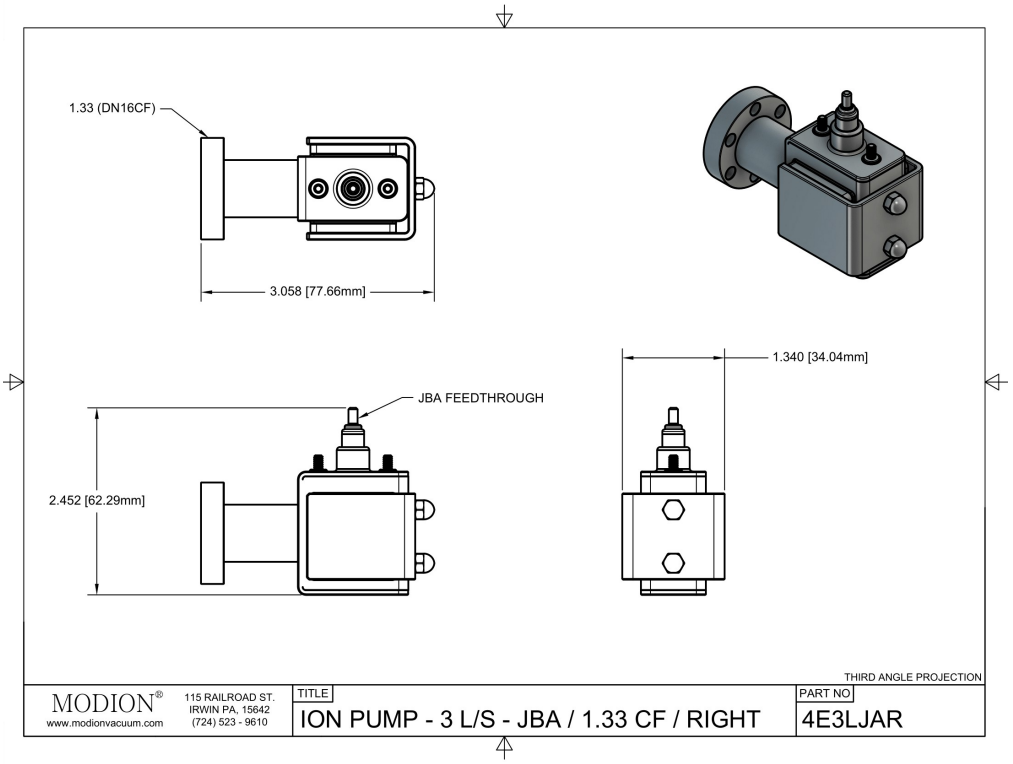


FIGURE 6

PK4E3LJAR-1766 3 l/s Package Right Orientation JBA Feedthrough

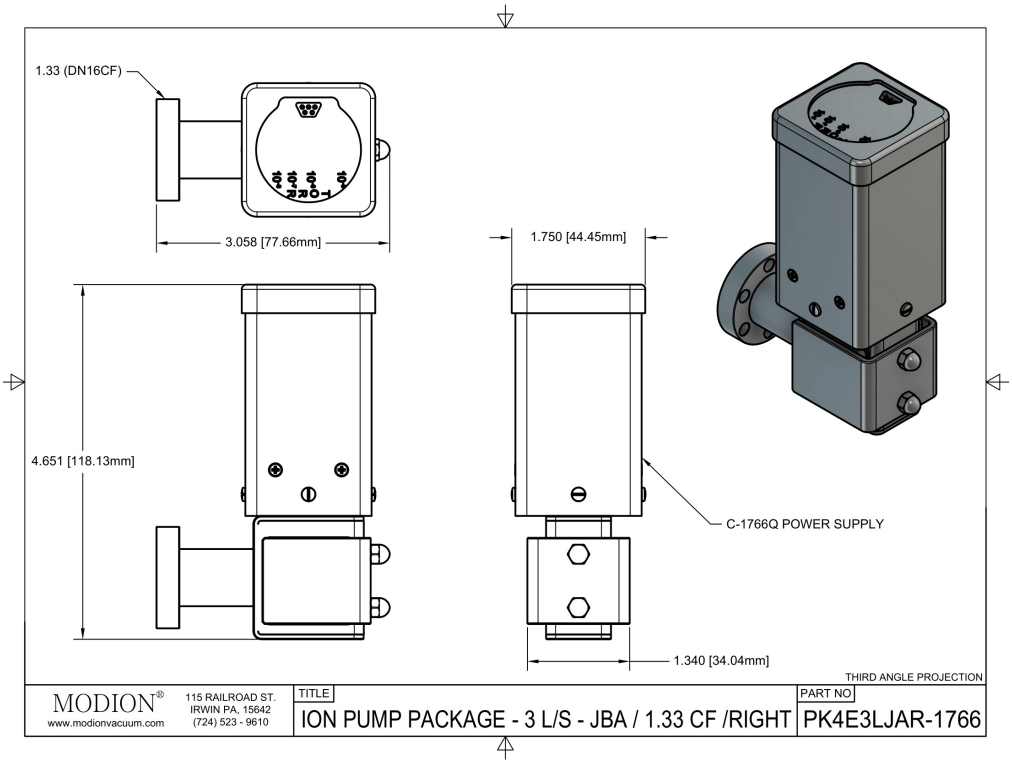


FIGURE 7

PK4E3LJAS-R1800 3 l/s Package Straight Orientation JBA Feedthrough For Use With R-1800

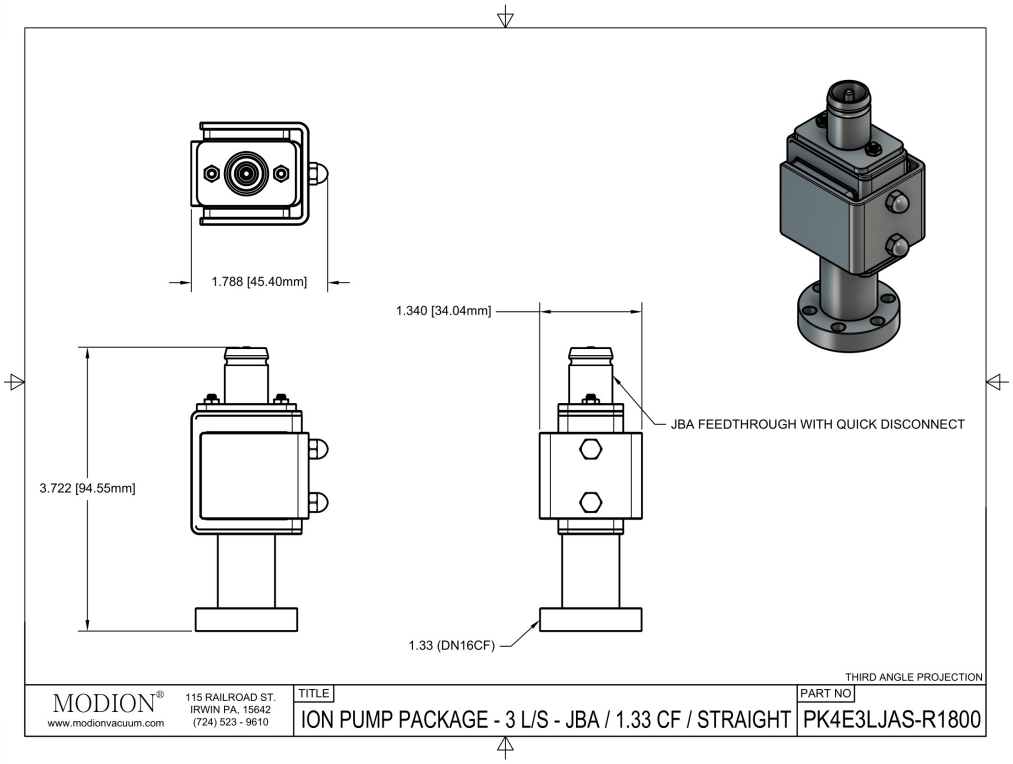


FIGURE 8

PK4E3LJAR-R1800 3 l/s Package Right Orientation JBA Feedthrough For Use With R-1800

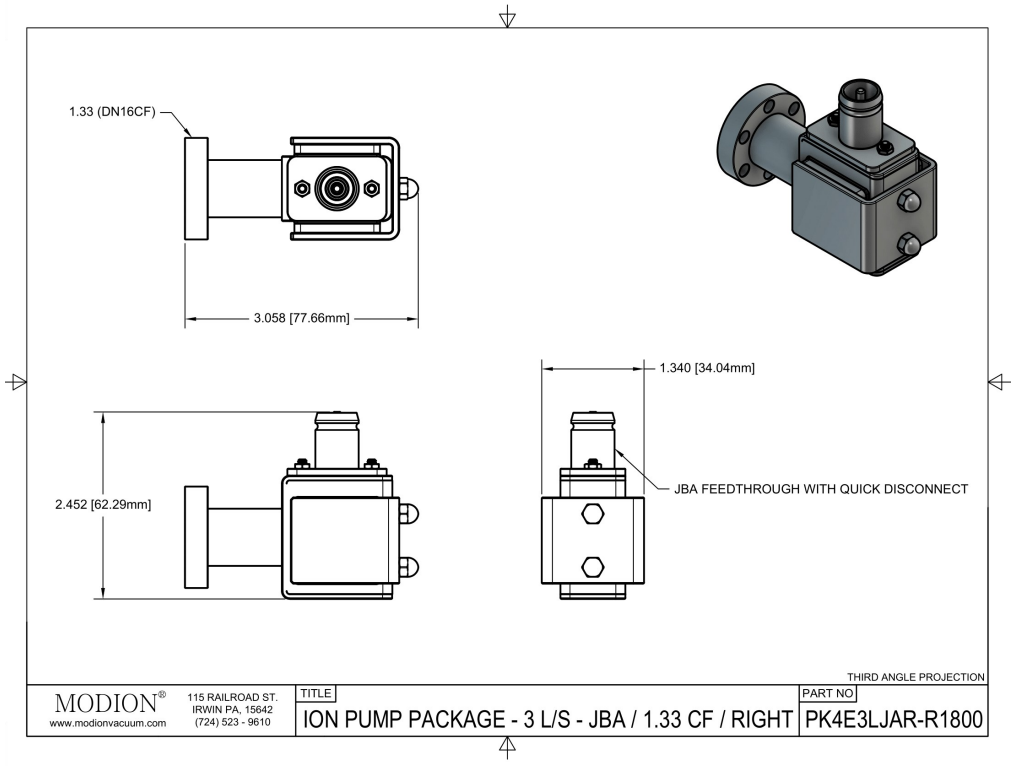


FIGURE 9

4E3LKAS 3 l/s Straight Orientation SHV Feedthrough

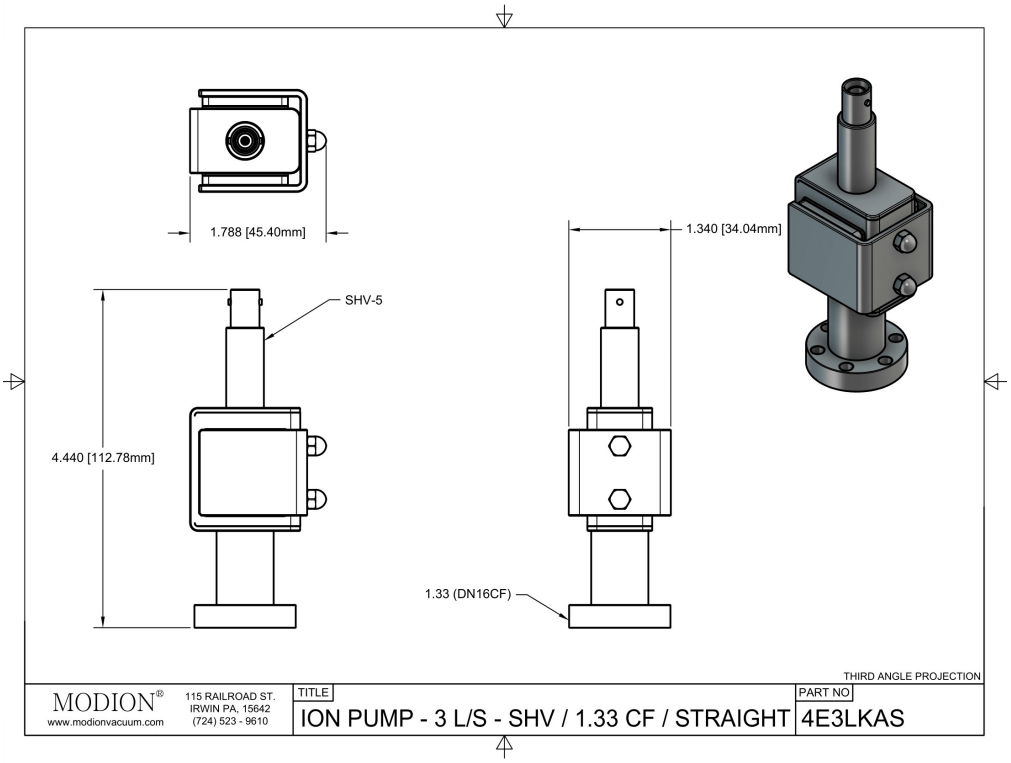
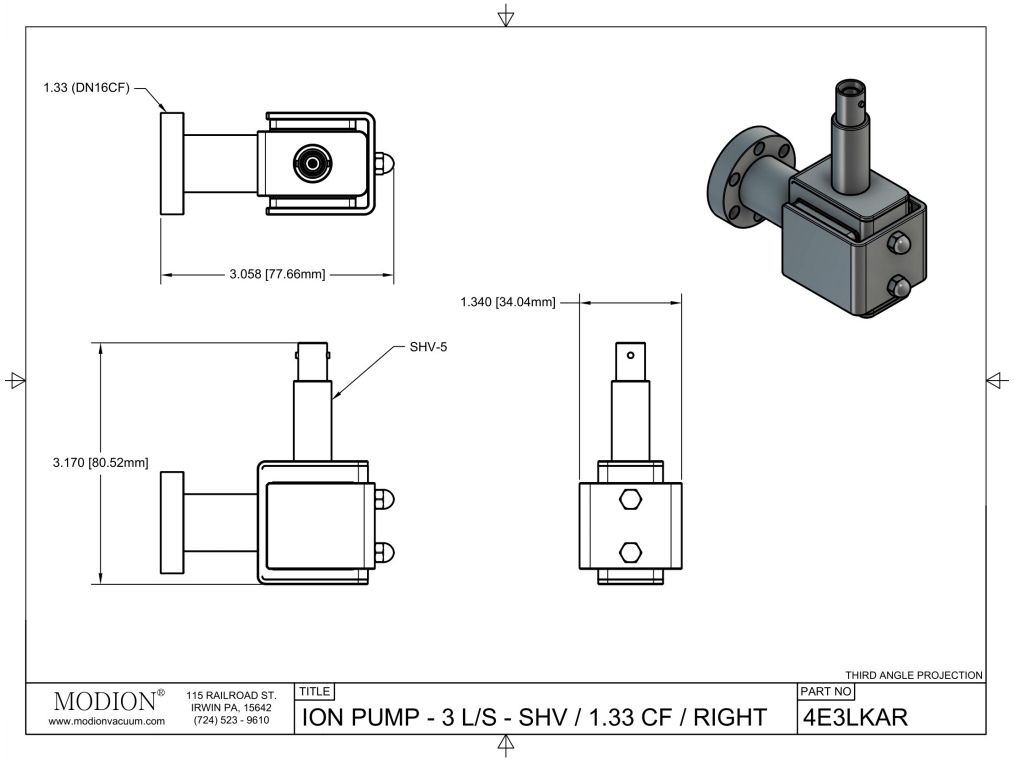


FIGURE 10

4E3LKAR 3 l/s Right Orientation SHV Feedthrough



Warranty Information

MODION® Inc. warrants all commercial MODION® systems to be free from defects in materials and workmanship for a period of twelve (12) months from date of shipment to customer when used in accordance with the accompanying instructions. All obligations of MODION® Inc. under this warranty shall cease in the event of abuse, alteration, misuse, improper installation or neglect of equipment. Reasonable care must be used to avoid hazards. MODION® Inc. expressly disclaims responsibility for loss or damage caused by use of the MODION® other than in accordance with proper operating procedures and conditions.

MODION® Inc.'s obligation under this warranty is limited to repair or replacement of the MODION®, at MODION® Inc.'s option. In no event shall MODION® Inc. be liable for any special, indirect, incidental or consequential damages.

MODION® Inc. makes no warranty of merchantability or fitness for any purpose, and no other warranty, oral or written, express or implied, except as specifically set forth in this limited warranty. No MODION® Inc. representative or distributor has any authority of power to alter or extend this limited warranty.

If the customer believes that a defect covered by this limited warranty exists, the customer must return the MODION® to MODION® Inc., postage prepaid, along with a description of the problem and proof of purchase, and contact information.