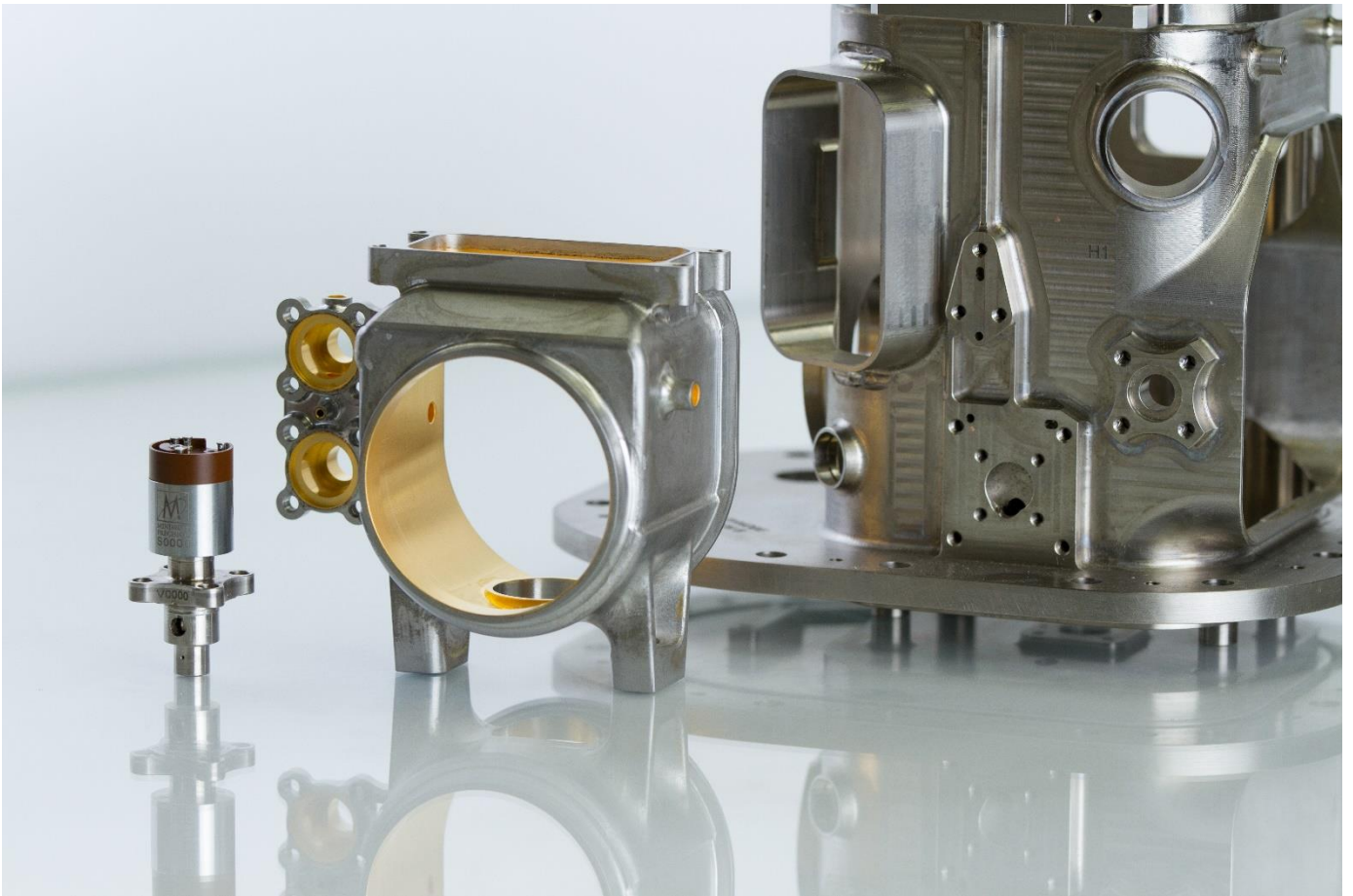


2020

MINDRUM PRECISION

Microvalve – End User Information Package



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MINDRUM PRECISION

Microvalve – End User Information Packet



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General Information

More information on the miniaturized double-latching solenoid valve with the lowest leak rate in the world.

Congratulations on the purchase of your Microvalve, the single most advanced and efficient miniaturized double-latching solenoid valve in existence! While your specific unit may be customized for your specific project or mission, the following information packet contains the general information that your engineering team will need to successfully integrate the microvalve into your system.

Microvalve customer service

Providing the highest quality customer service is extremely important to us, and whether you have purchased a single unit for testing purposes or you have sixty units on a rover application, we are here to answer any questions that you might have. If you ever have any issues or concerns with your Microvalve at any time, please reach out to your point of contact at our company, or contact us at:

**Mindrum Precision,
10,000 Fourth Street
Rancho Cucamonga, CA 91730 USA
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sales@mindrum.com**

Microvalve History

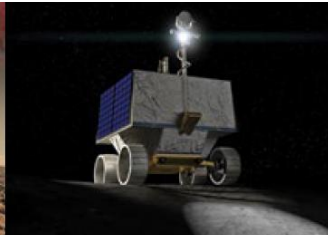
After being originally designed by NASA Goddard Space Flight Center, the Microvalve has become the definitive go-to valve for both US-based and international instrumentation suites on off-earth missions. As the closest thing in existence to a zero leak-rate miniaturized solenoid valve, we are proud to have manufactured Microvalves for a large number of high profile missions, and our company received a Robert H Goddard Award for Exceptional Achievement in Engineering from NASA for our contribution to MAVEN, when we successfully developed the manufacturing process for this extremely intricate device and brought the Microvalve design off of the page and into reality.

Our Microvalves continue to be used in some of the most ambitious missions in spaceflight, and Mindrum Precision is proud to continue to be a trusted partner of NASA, JPL, ESA, SWRI, Northrop Grumman, Lockheed Martin, L3Harris, SpaceX, and many other companies and organizations that push the limits of human capabilities in search of a better understanding of our universe. As a top-tier machined component manufacturer, our contributions to these projects often extended beyond the Microvalves, and included custom components as well, including complex Microvalve housings and other tight tolerance work in glass, ceramics, and metals. Among many others, our Microvalve was utilized in all of these programs:



CURIOSITY ROVER

Surface Analysis at Mars (SAM)



VIPER ROVER

Mass Spectrometer Observing Lunar Operations (MSOLO)



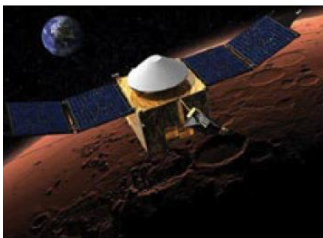
SOLAR ORBITER

Spectral Imaging of the Coronal Environment (SPICE)



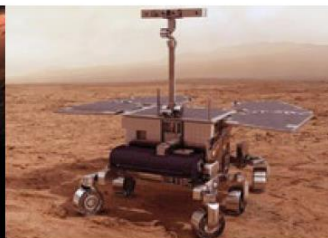
ORION

Multi-Platform Air Monitor (MPAM)



MAVEN

Neutral Gas and Ion Mass Spectrometer (NGIMS)



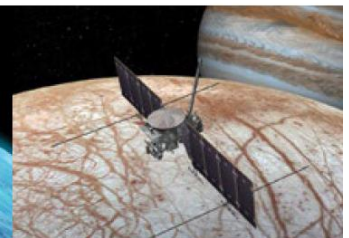
EXOMARS

Mars Organic Molecule Analyser (MOMA)



INT'L SPACE STATION (ISS)

Spacecraft Air Monitor (SAM)



EUROPA CLIPPER

MASS SPECTROMETER FOR PLANETARY EXPLORATION (MASPEX)

General Specifications

The following information is for our standard Microvalve unit. One of the many strengths of our Microvalve program is our ability to customize to meet customer requirements, so variations on these specifications may be available upon request.

Parameter	Value
Mass (total)	25 grams
Mass (moving)	2 grams
Height (overall):	1.616"
Height (above manifold):	1.101"
Valve Orifice Diameter	0.070"
Pintle/Poppet Travel	0.030"
Helium Leak Rate (instantaneous)	$< 1 \times 10^{-10}$ atm-cc/sec
Helium Leak Rate (steady state)	$< 5 \times 10^{-9}$ atm-cc/sec
Operational Temperature	-60°C to +220°C
Actuation Time	< 1 millisecond
Maximum Differential Pressure	200 psi
Rated Flow Coefficient (C_v)	0.11
Coil Resistance (Series)	3.5 Ω
Coil Inductance (Series, Valve Open)	1.7 mH

Materials List

The Microvalve was designed by NASA specifically for spaceflight, with contamination, radiation, conductivity, and durability as only a few of the many criteria used when selecting materials to be included in this component. The materials used are as follows, with the materials denoted with an Asterix (*) being exposed to the gas flow.

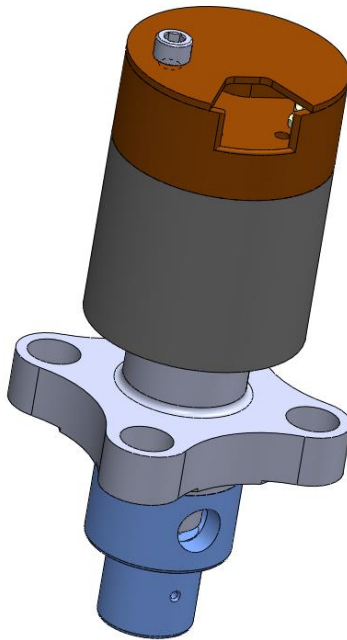
- ***Tantalum**
- ***Titanium 6AL-4V (per AMS-6931 and AMS-4911)**
- ***Inconel 718**
- ***CRES 304**
- ***CRES 321**
- ***Vespel SP-22**
- Inconel X-750
- Vespel SP-1
- Magnesium partially stabilized Zirconium oxide
- Hiperco 50A
- Nickel 201
- Samarian Cobalt magnet alloy S3069
- Brass 360
- Beryllium nickel 440
- Kovar F15
- Corning 7052 glass
- A286
- MW35-C magnet wire
- M22759/82 hook-up wire
- MIL-W-3861 bus wire
- MIL-T-43435B type IV lacing cord
- Liquid crystal polymer per ASTM D5138
- Beryllium Copper C17200
- Adhesives/solder/braze
 - Brazing alloy BVAg-8
 - Master Bond EP65HT-1
 - Duralco 4460
 - Stycast 2850FT
 - Pb95Sn5 solder
- Coatings/platings
 - Nickel (MIL-C-26074)
 - Dicronite DL-5 (DOD-C-85645 type I)
 - Tin/lead
 - Gold (ASTM B488 type II code C class 1.27)

Technical Dimensions

This section contains technical drawings for physical dimensions. If further information is required or needed, please reach out to your point of contact at Mindrum Precision.

Isometric View

Standard Microvalve configuration pictured below. Again, many customization options are available, so your unit may vary from the picture based on provided specifications.

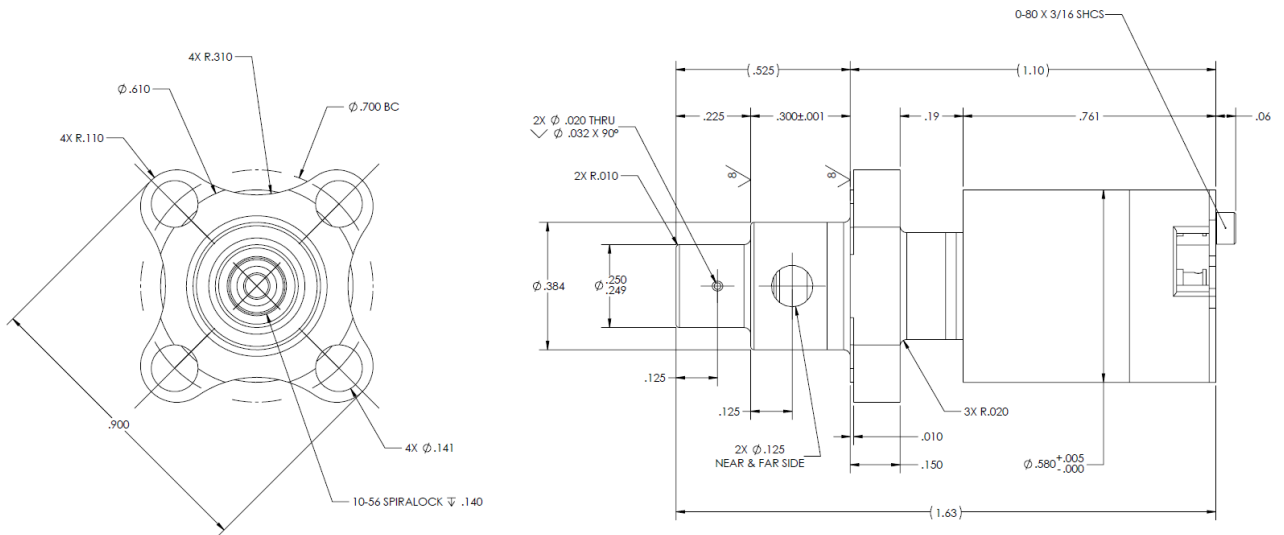


In addition to manufacturing the Microvalve, Mindrum Precision also is an industry-leading manufacturer of precision components, including everything from manifolds

MICROVALVE - END USER INFORMATION PACKET

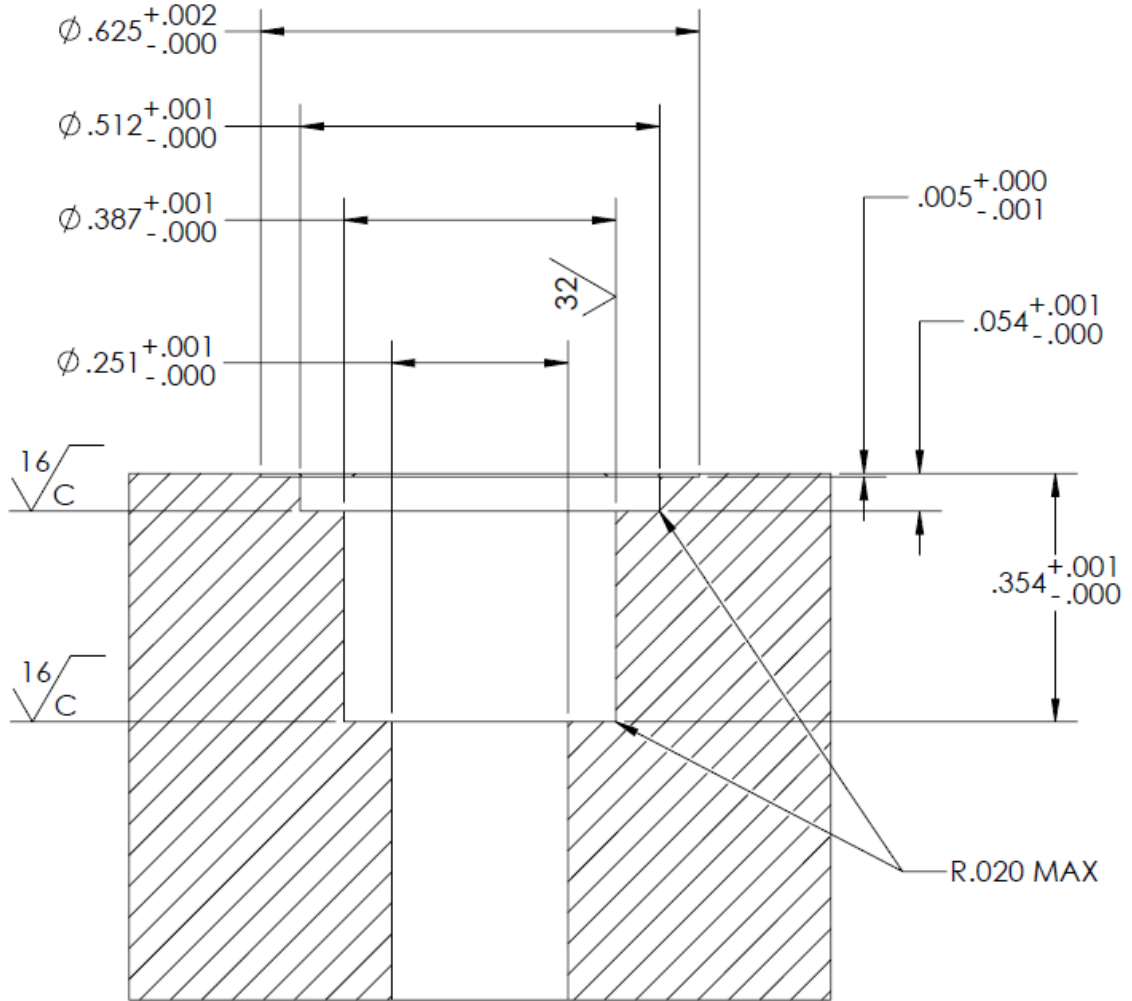
and housings for use with the Microvalve to other machined components in optical materials, technical ceramics, and metals. If your project requires further assistance, contact us at any time and we will be happy to address whatever needs you might have.

Valve Dimensions



Dimensions listed are in inches. All tolerances not shown are $\pm .002''$

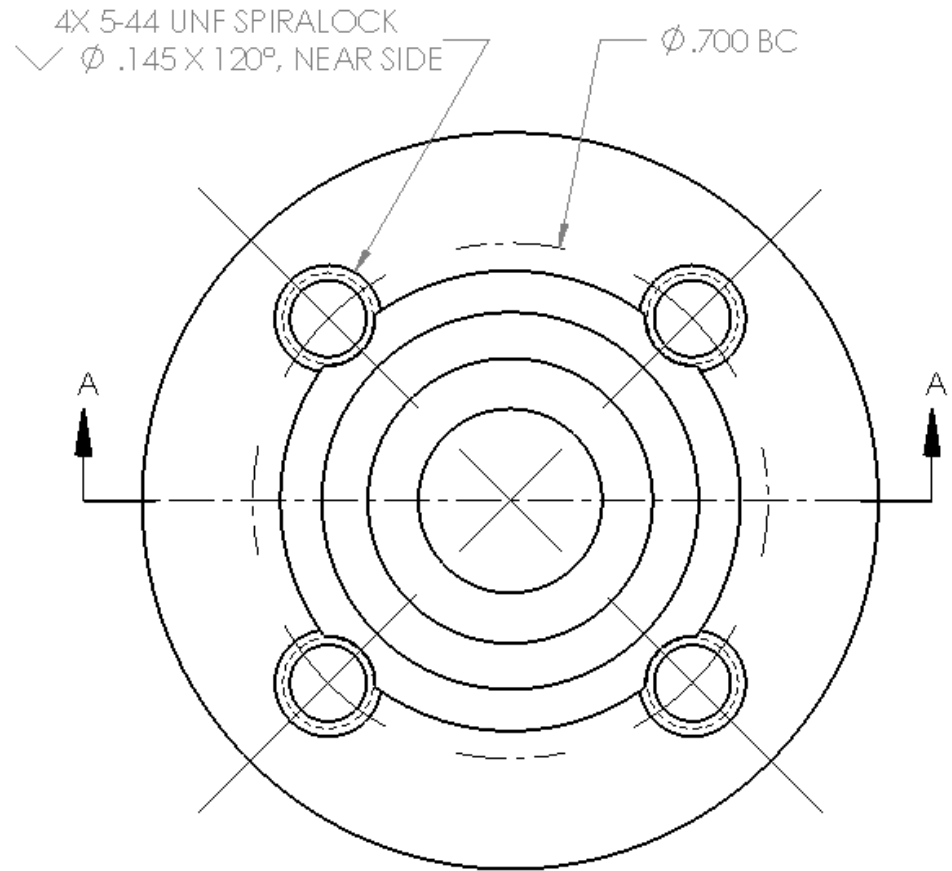
Manifold Port Dimensions – Side View



SECTION A-A

Dimensions listed are in inches. All tolerances not shown are $\pm .002$ "

Manifold Port Dimensions – Top View

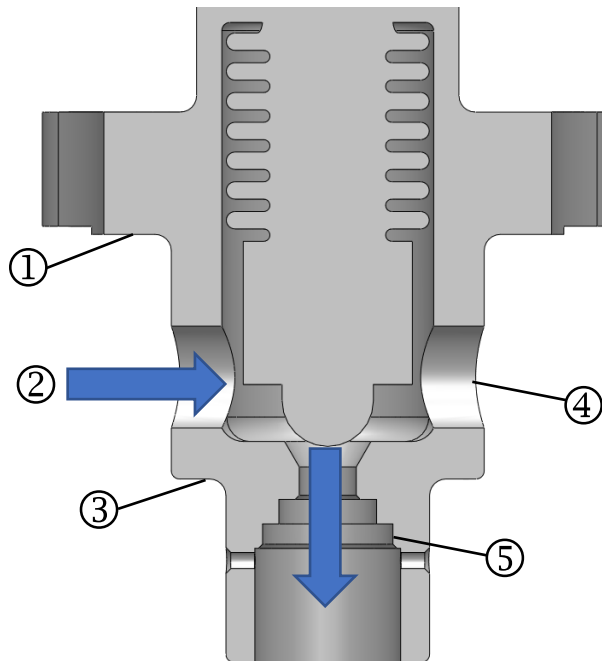


Dimensions listed are in inches. All tolerances not shown are $\pm .002''$

General Use and Installation

Gas Flow and Sealing Surfaces

- ① Sealing Surface - Upper Seal
- ② Blue arrows indicate standard direction of gas flow
- ③ Sealing Surface - Lower Seal
- ④ Secondary port
- ⑤ Gland nut port



While the standard configuration is as shown above, gas flow can be directed in either direction. The secondary port allows for direct passage of gases regardless of valve state, but can be omitted if not required for your application. When in use, gas flows around the vespel pintle tip, while the bellows isolates the actuator from the gas flow. All of the components in the gas flow are inert and lubricant-free. The gland-nut port has a sealing surface (not shown in the diagram) to seal gas flow to the tube or hardware that is connected to the Microvalve.

Installation into the Manifold Port

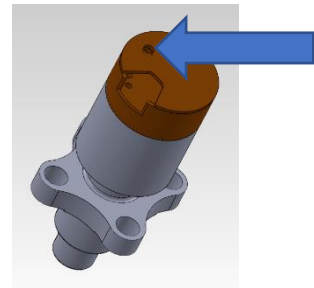
With a standard manifold produced by Mindrum Precision, installation of the Microvalve into the manifold port is a relatively simple procedure, but care still must be taken to ensure that the Microvalve is not damaged during this process. Always use a torque wrench and follow the listed parameters when tightening screws, and contact Mindrum Precision directly if you have any questions outside of the scope of this document before proceeding.

The process can be broken down into four steps: Removing the solenoid from the valve body, installing the valve body into the manifold with both seals, securing the valve body to the manifold through the flange, and reattaching the solenoid to the valve body once all other steps have been completed.

Step 1: Remove the solenoid from the valve body

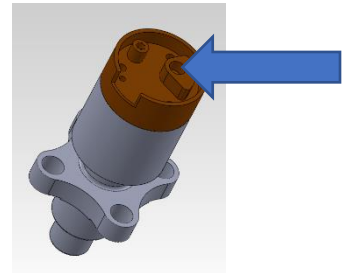
First, remove the electrical cap cover:

1. Remove #0-80 screw
2. .050" hex driver required
3. Remove Electrical Cap Cover

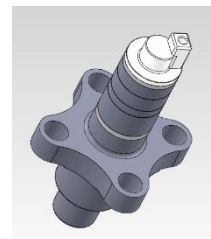


Next, remove the solenoid:

1. Remove #0-80 screw from electrical cap
2. .050" hex driver required
3. Solenoid will slide off valve body
4. Permanent magnet will provide slight resistance



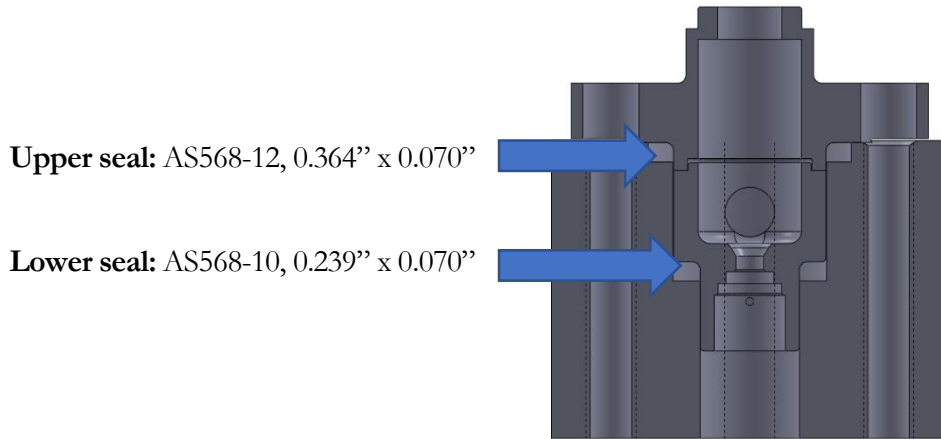
The valve body will now be ready for installation.



Step 2: Installing Seals

Ensure seals are properly installed before attaching the microvalve to the manifold. If your application requires an inert material to be used for the seal, Mindrum Precision can provide custom gold C-seals for this purpose as a standard solution.

If standard O-rings are used, we recommend using the following:



Upper seal: AS568-12, 0.364" x 0.070"

Lower seal: AS568-10, 0.239" x 0.070"

Step 3: Securing Through the Flange

Once Step 2 is complete, the Microvalve can be secured to the manifold. If your application is using a manifold produced by Mindrum Precision, use four (4) #5-44 socket head screws going through the flange into the threads in the manifold. Using a torque wrench with a 3/32" hex driver, install to the following recommended torque depending on the screws used:

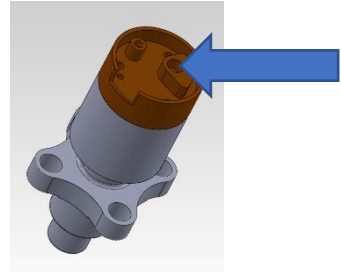
- 120 ksi screw, lubricated: torque to 14-15 in-lbs
- 150 ksi screw, lubricated: torque to 19-21 in-lbs

Step 4: Installing the Solenoid

After securing the flange to the manifold, you are now ready to re-install the solenoid. The first step is sliding the solenoid back onto the valve body.

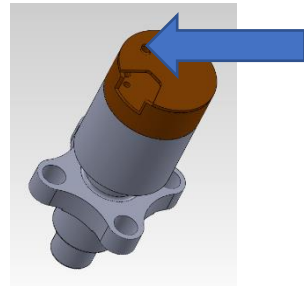
Next, reattach the electrical cap to the valve body. Once again, a .050" hex driver will be required.

1. Place electrical cap on the solenoid.
2. Reinstall the #0-80 screw into the electrical cap.
3. Torque to 2.3 in-lbs



Next, reinstall the electrical cap cover:

1. Place the electrical cap cover on the electrical cap.
2. Reinstall the #0-80 screw as shown
3. Torque to 0.9 in-lbs

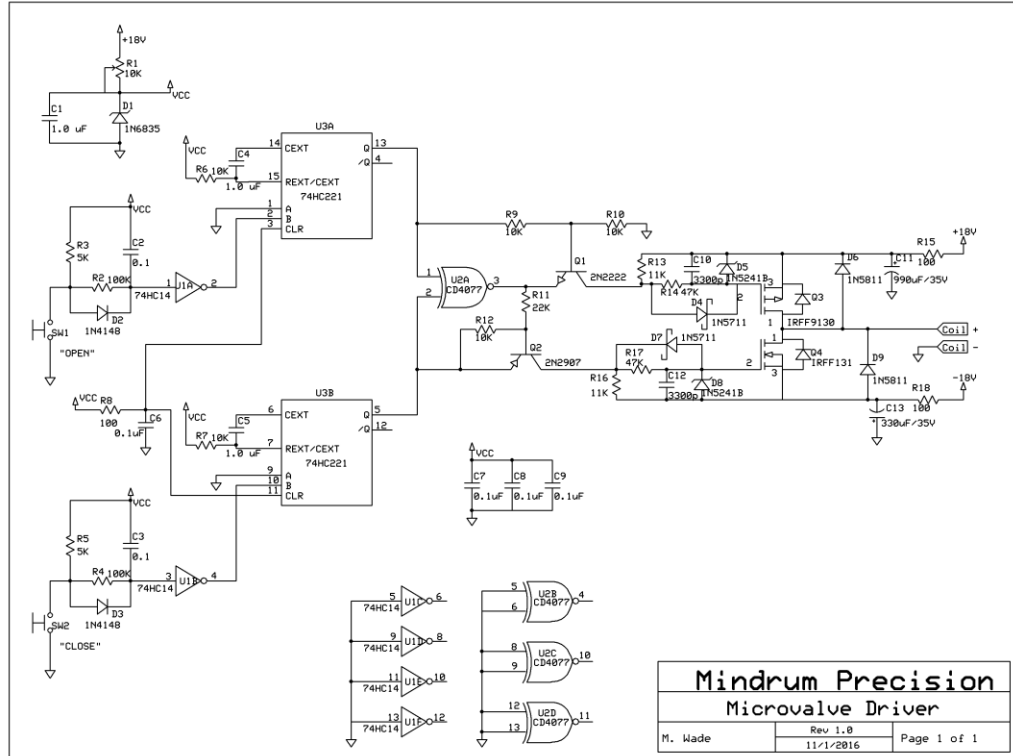


Electrical Requirements

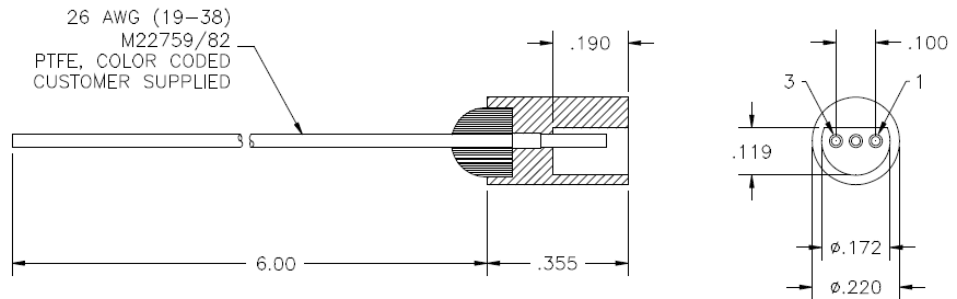
As a double-latching solenoid valve, the Microvalve does not require power to remain in either an open or closed state, but it does require electrical input to drive it from one state to the other. The electrical requirements and specifications of the standard microvalve are as follows:

- Standard configuration for the Microvalve is to have both pins in series, with Pin 1 (Gray) and Pin 2 (Pink) are on the same circuit along with the solenoid coils. Parallel configurations are also available upon request.
- The standard mating connector used for the Microvalve is made by Omnetics, part #A22002-001. With this connector, the valve has the following required inputs:
 - **To open:** +18 to +28VDC pulse for 7 ms on Pin 2
 - **To close:** -18 to -28VDC pulse for 7 ms on Pin 2
 - **Approximate current draw:** 4A minimum. We recommend designing to 7A to provide a margin for any potential variation.

Electrical Schematic of Driver Circuit



Microvalve Wire Harness



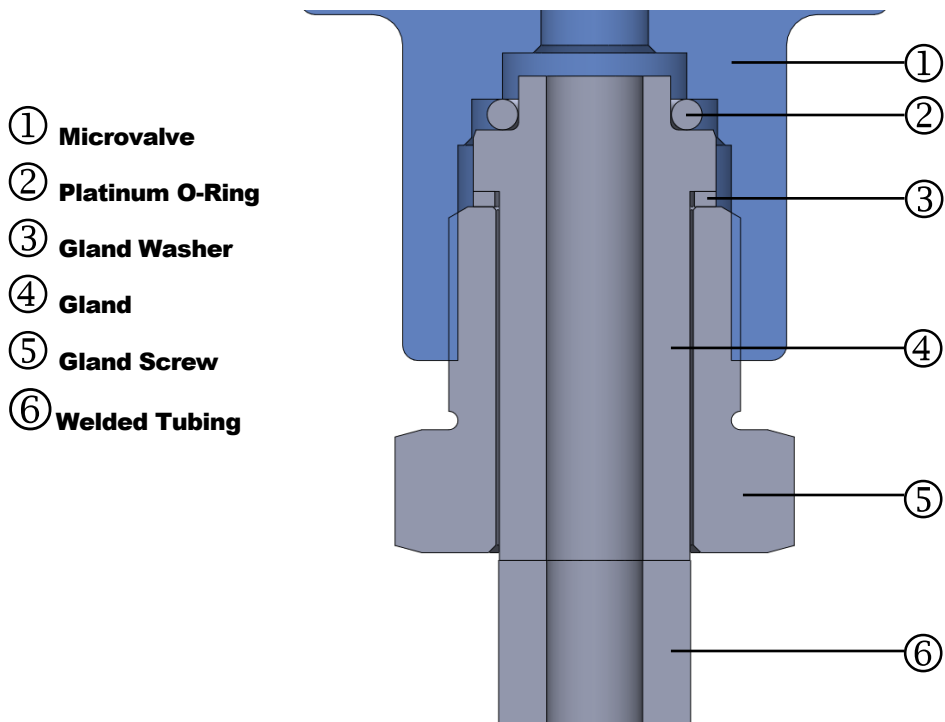
SOCKET #	COLOR
1	GRAY
2	PINK
3	YELLOW

Section
4

Gland Assembly

Once the tubing or hardware that the microvalve will mate to is established, the gland assembly will mate with the Microvalve as pictured below.

Gland Assembly Diagram



Gland Screw Installation

When installing the gland screw, use of the proper torque parameters is important to both achieve a tight seal, as well as to avoid damaging the unit.

Before installing the gland screw, apply a dab of Braycote 601EF High Vacuum Grease to the threads of the gland screw.

For installing the screw, use a #7 spline screw wrench (MS33787). If needed, contact Mindrum for purchase options for this item. Align your torque wrench so it is perpendicular to the gland screw wrench, and use the following torque.

- 10-56 Spiralock Torque Value: 46 in-lbs

Please note that this value is valid for having the torque wrench and the gland assembly wrench in a perpendicular orientation to each other; if the wrenches are in-line with each other, the above values no longer apply.

Handling and Warranty Information

The Microvalve is a robust and solidly designed component, but like all precision instruments designed for space flight, it must be handled with extreme care to avoid damage and ensure optimal performance.

General handling information

The Microvalve is a complex component that contains over sixty unique parts, including ceramic, electronic and mechanical components. Never apply force or shock to the Microvalve at any time. If you believe that your unit has been damaged, alert your contact at Mindrum Precision immediately for further instructions and do not integrate into a final system without returning the unit for evaluation.

Cleaning

To clean the microvalve, remove solenoid assembly using the steps listed above, submerge the valve body in isopropyl alcohol, and ultrasonically clean the valve body for 15 minutes. Blow drying with clean nitrogen is recommended. Make sure that the unit is completely dry prior to reattaching the solenoid.

Warranty information

Unless otherwise specified, Mindrum Precision Inc warrants the system for a period of twelve months from the date of delivery. This warranty, however, is subject to the following conditions:

1. Mindrum Precision shall be under no liability in respect to any defects in the equipment arising from any drawing, design or specification supplied or modification requested by the customer.
2. Mindrum Precision shall be under no liability in respect to any defects arising from normal wear and tear, willful damage, negligence, abnormal working conditions, failure to follow Mindrum Precision's instructions (whether oral or in writing), misuse, alteration or repair of the equipment without Mindrum Precision's approval.

Claims in respect to defective equipment must be directed to Mindrum Precision. The customer, pending direction from Mindrum Precision, must retain the equipment. Following authorized return of the equipment, which must be made by the customer on freight prepaid basis, Mindrum Precision will examine the equipment and if the claim is justified, Mindrum Precision will repair the defective equipment or make replacement without charge. Mindrum Precision will have no further liability.

Other questions?

At Mindrum Precision, we pride ourselves on our customer support, and will work with you from your initial RFQ all the way through the launch of your project. Whether it is specific questions about the Microvalve, requests for custom housings or components, or anything else, feel free to reach out to us at any time and we will address your needs.

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