



## VEHICULAR SLIP RINGS

### RELIABLE SIGNAL AND POWER COUPLING IN THE MOST RUGGED BATTLEFIELD CONDITIONS



The increasing complexity of modern military vehicles demands slip rings that provide reliable electrical interfaces between the stationary and rotating parts of these vehicles. Moog slip rings have been chosen to operate on numerous vehicular programs to meet these challenges. M1 / A2 and M60 tanks, A2 / A3 Bradley Fighting Vehicles, Stryker, Light Armored Vehicles (LAVs), and V150 Commando Vehicles are just a small sample of these vehicular programs.

Technological developments have yielded stabilized gun systems, laser target acquisition and fire control systems, and high bandwidth data communications that create unique demands for vehicular slip rings. We meet all of these challenges effectively and economically. A sampling of our many active vehicular slip ring designs are shown on the following pages, or our engineering department can tailor a slip ring for your vehicular application, often within the existing envelope. Contact us with your requirements.

#### FEATURES

- Supports modern data communication technologies
- Full environmental sealing capabilities
- EMI shielding available
- Range of operating voltages compatible with any vehicular system
- Hydraulic rotary joint options
- Gold-on-gold contacts for signal and data integrity
- Meets military shock and vibration requirements
- Speed, torque and frequency characteristics designed for specific vehicular applications
- High power capability to support present and future vehicular system needs
- High frequency coax channels available
- Through-bore designs
- Cam-operated microswitches
- Vertical integration with resolvers, fiber optics, fluidic interfaces, hydraulics, pneumatics and motors
- Filtered air transfer for chemical, biological and radiological (NBC) requirements and / or electronics cooling and pneumatic rotary joint options for crew station breathing and electronic cooling
- High speed data capabilities

#### TYPICAL APPLICATIONS

- Tanks
- Light armored vehicles
- Armored personnel carriers
- Retrievers
- Armored field artillery vehicles
- Brigade command vehicles
- Reconnaissance vehicles
- Mobile missile launchers
- Independently rotating commander stations
- Forward-Looking-Infra-Red systems (FLIRs) or viewers

# VEHICULAR SLIP RING DESIGN CRITERIA

Electrical slip rings are used in vehicles such as tanks, retrievers, light armored vehicles, mobile missile launchers, and armored personnel carriers. A typical vehicle might contain slip rings in the turret, the commander station and the infrared sight. In each of these systems, slip rings have provided reliable signal and power coupling under the most rugged battlefield conditions.

In addition to producing compact slip rings where minimal space is available, we have provided units that combine conventional electrical slip rings with resolvers, encoders, fiber optics, pneumatics and hydraulics rotary joints.

## Design

Moog can offer the most valuable design assistance by being involved early in the development of the vehicle. The internal design of the slip ring capsule will be driven by the circuit requirements and the space available for mounting the slip ring capsule. From our vast product line, we can pull from the following design criteria:

- use of existing designs
- single drum
- concentric drums
- single pancake
- stacked pancakes
- combination of designs

- clear through-bore to allow another device to occupy the centerline
- connectors - case mounted or attached to cables
- mechanical support - on either side of the rotating interface

## Power Circuits

Theoretically, there is no limit to the amount of power that can be transferred by the slip ring capsule. Most hull-to-turret slip ring capsules are capable of transferring 150 amps continuously. It is important that the power duty cycles (including surge currents) be accurately defined as early as possible in the design stage. (Requiring the slip ring capsule to operate at continuous current levels that will not be encountered in the field takes space that could be more effectively used for signal requirements.) If the space available for the slip ring capsule is limited, it may be advantageous to transfer the power at higher voltages and lower currents. The power ground can be made through the case of the slip ring capsule or insulated from case ground.

## Signal Circuits

Signal requirements for vehicular slip ring capsules continue to be increasingly demanding. The circuit functions and electrical isolation requirements have a significant impact on the design of the slip

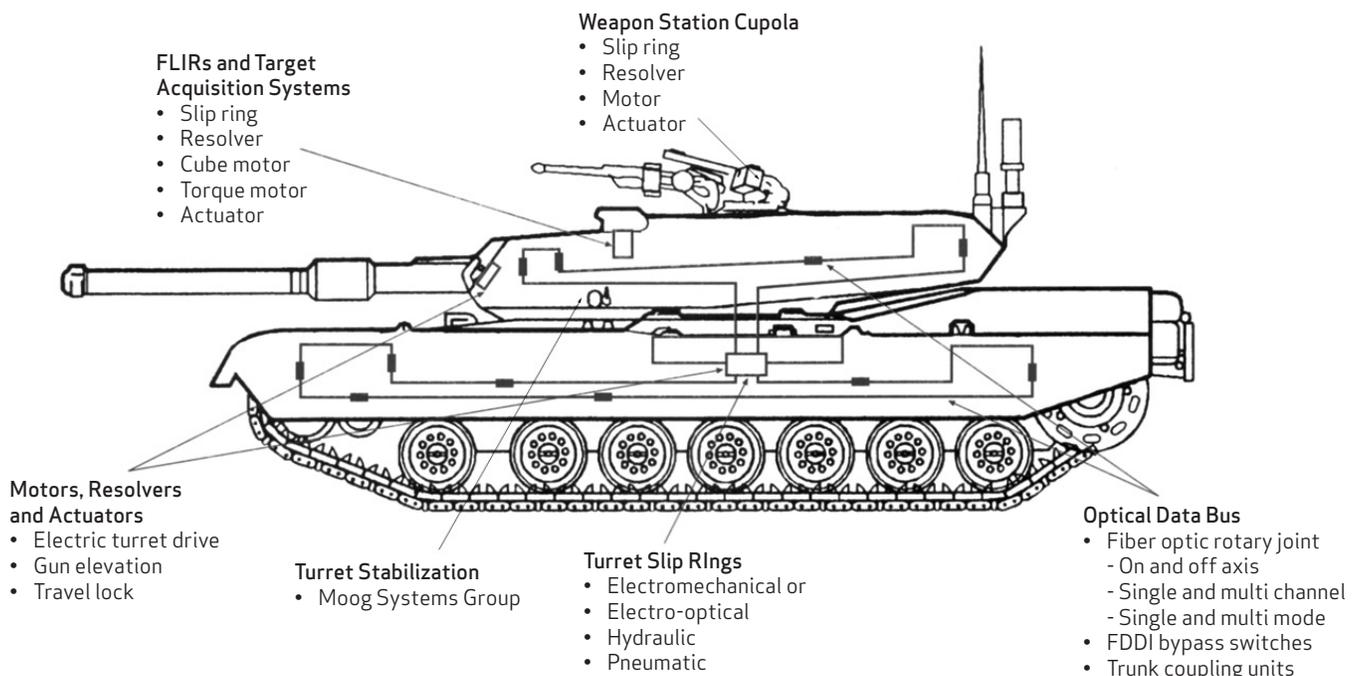
ring capsule. A typical vehicular slip ring will include circuits for powering electronic equipment, video circuits, and analog and digital control circuits.

Sometimes it is important that sensitive circuits have additional isolation from other circuits to meet heightened sensitivity requirements. Circuit isolation requirements are more easily addressed early in the design stages.

## Slip Ring Expertise

Vehicles such as tanks, retrievers, mobile missile launchers, light armored vehicles and armored personnel carriers pose a variety of challenges. Hydraulically-actuated equipment in the turret may require the combination of conventional electrical slip ring with a hydraulic joint to form an electro-hydraulic slip ring, thereby providing reliable fluidic interfacing. The threat of a NBC environment may require pneumatic channels through the slip ring to provide filtered air to crew members' face masks. The introduction of an independently rotating commander station or cupola may require a slip ring large enough in diameter to encompass the station, yet very thin in cross section to minimize space requirements. These advances in military technology, plus many others, have challenged the capabilities of the slip

## COMPONENTS FOR VEHICULAR SYSTEMS



# VEHICULAR SLIP RING DESIGN CRITERIA

ring industry, demanding equally sophisticated solutions for reliable vehicle operation.

Moog consistently meets these challenges successfully and economically. For more than 50 years we have been involved in the design, development, and production of quality slip rings for many diverse applications. Recognized as leaders in slip ring research and testing, our team of engineers, scientists, and manufacturing personnel have focused their total resources toward one goal—providing you with the best possible product.

### To that end, we have:

- Established a complete Research & Development team, conducting numerous on-going studies in such areas as tribology — the science of friction, wear and high bandwidth communication.

- Studied the effect of environmentally-induced contaminants on slip ring contacts and made substantial progress in making slip rings more tolerant of hostile environments.
- Consolidated all of the functions of product design, tool design, manufacturing, and product testing into a well-integrated in-house operation certified to AS9100 Rev. C ISO 9001-2008.
- Combined field-proven slip ring designs with high-volume tooling techniques resulting in high quality hull-to-turret slip rings at attractive unit prices.
- Presented technical papers dealing with the field of electrical contacts and the applications of our technology to a diverse marketplace.

In view of our many years of applications experience and proven performance, it is

easy to understand why our slip rings have been chosen to be used on numerous vehicular programs, including:

- APC
- 8x8
- M60 A1 and A2
- M728 CEV
- HSTV
- Centurion
- M2 and M3 Bradley
- Commando V150
- Leopard
- Stryker
- M48
- AAV
- LAV
- Bionix



The following table presents a cross-section of our vehicular designs. These products are for reference purposes only. Please contact the factory concerning your requirements. Tooling charges may apply.

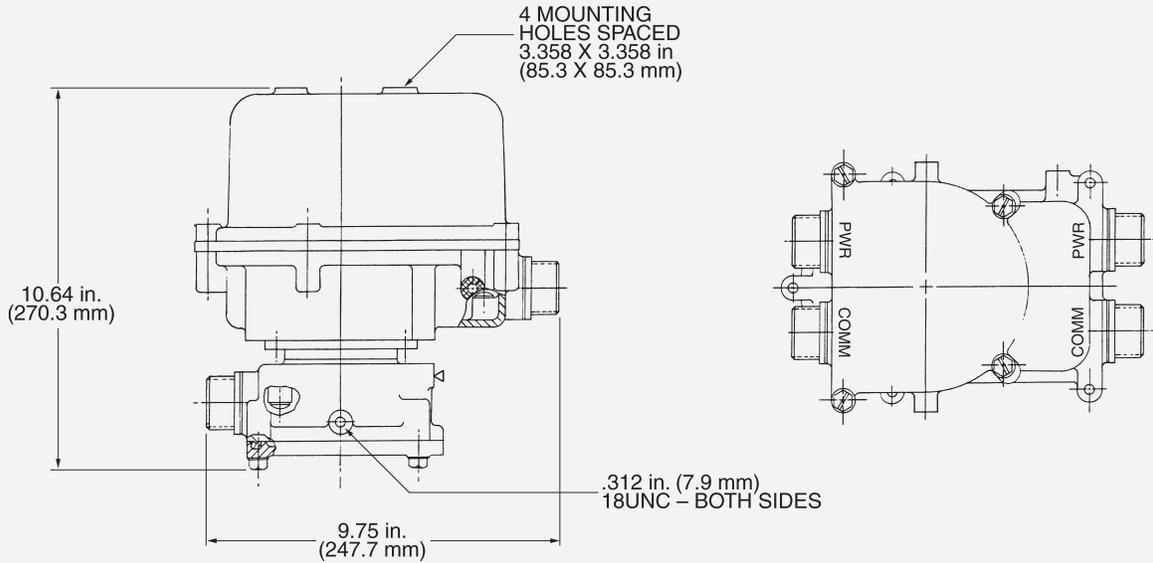
## VEHICULAR AND TURRET SLIP RING SPECIFICATIONS

Vehicular Slip Ring	POWER			SIGNAL			Comments
	No. of Circuits	Cont. Current Rating	Voltage Rating	No. of Circuits	Gauge or Type	Intended Signal	
AC3497	1	150 amps	Ground	12	Control	5 amps, 150 V	2 cam design for dual fire control Variations available
AC6033	1	150 amps	Ground	18	Control	5 28 VDC	Dual cam NBC air channel Variations available
VSR-3733	2	200 amps	24 VDC	42	20 AWG	3 amps, 28 VDC	NBC air channel Size similar to VSR4994
VSR-4906	2	200 amps	24 VDC	61	20 AWG	3 28 VDC, 28 VDC	NBC air channel Size similar to VSR4994
VSR-4994	4	200 amps	24 VDC	86	24 AWG	2 - 4 amps, 28 VDC	NBC air channel (2) 1553 Data-bus (8) RS-170 Video
VSR-6057	2	250 amps	18 - 37 VDC	238	24 AWG	2 - 4 28 VDC, 28 VDC	EMI features concentric rings and high isolation
VSR-6772	2	450 amps 75 amps	28 VDC	150	28 AWG	100 Mbit Ethernet	Contains resolver, R to D network, power distribution network and pneumatic and hydraulic rotary joint
VSR-2000	2	50 amps	250 VDC	12 or 24		10 amps, 250 VDC	High current and alternate signal configurations available
VSR-7001	2 4 4 11	150 amps 120 amps 80 amps 13 amps	20 - 33 VDC	32 18 6 13 4	22 AWG 24 AWG 28 AWG Twinax MIL-C-17 / 94 28 AWG Twinax	5 amps, 20 - 33 VDC 3 amps, 20 - 33 VDC Serial Data RG-179 Gigabit Ethernet	Gigabit ethernet channels Immersible to 1 meter (2) RS-170 video Air channel

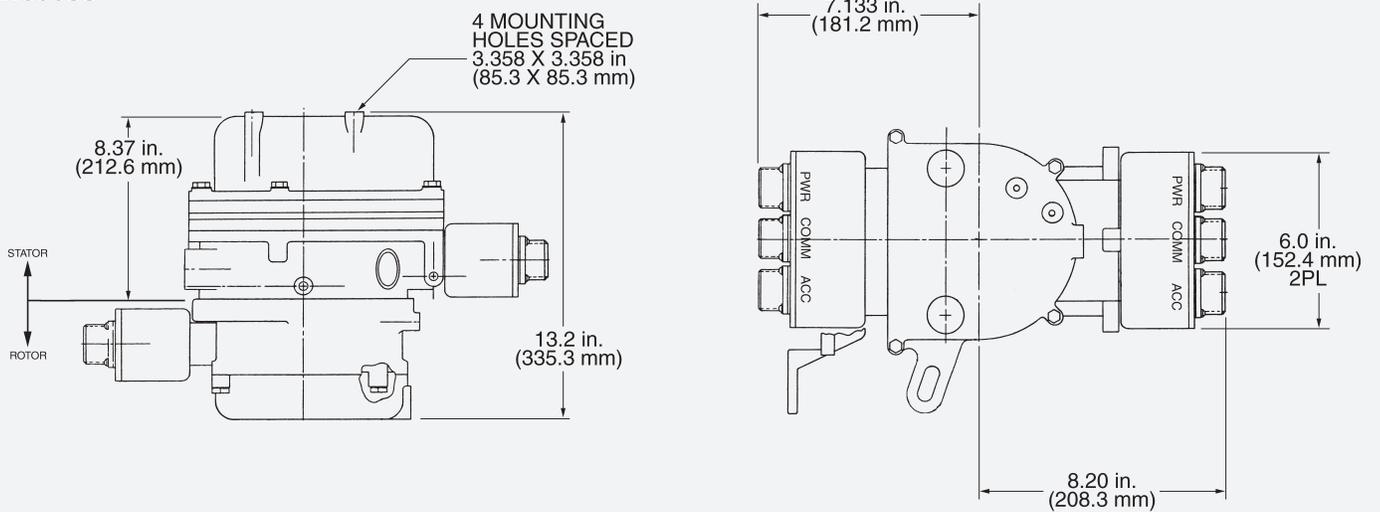
# VEHICULAR SLIP RING DESIGN CRITERIA

## MECHANICAL DIMENSIONS INCHES (MILLIMETERS)

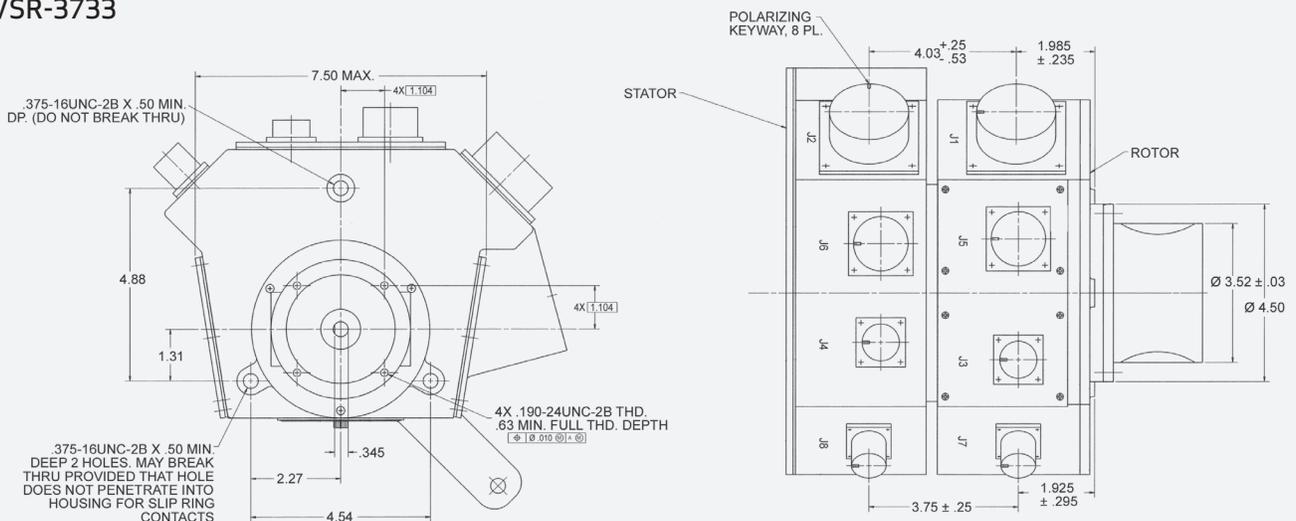
AC3497



AC6033



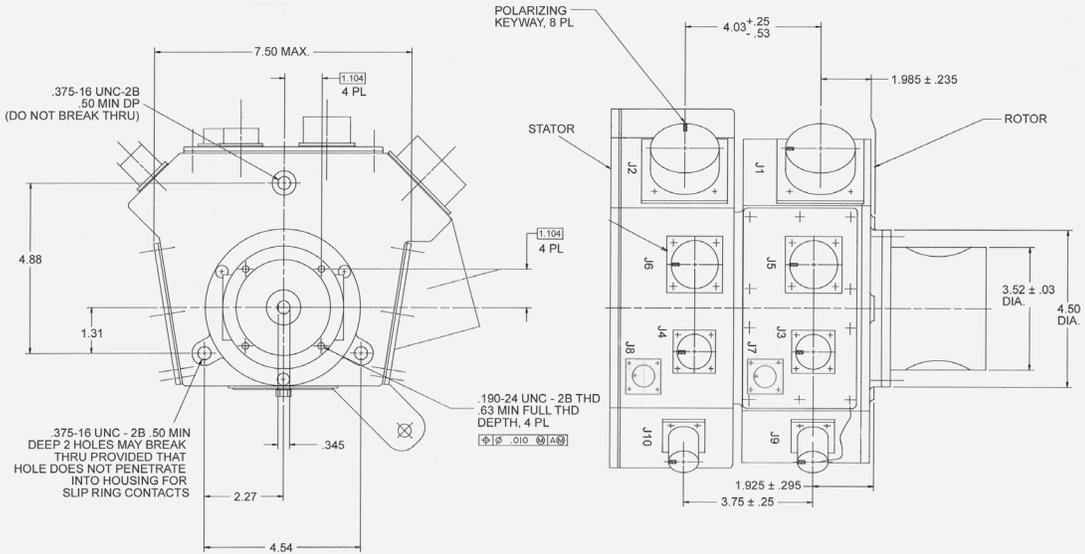
VSR-3733



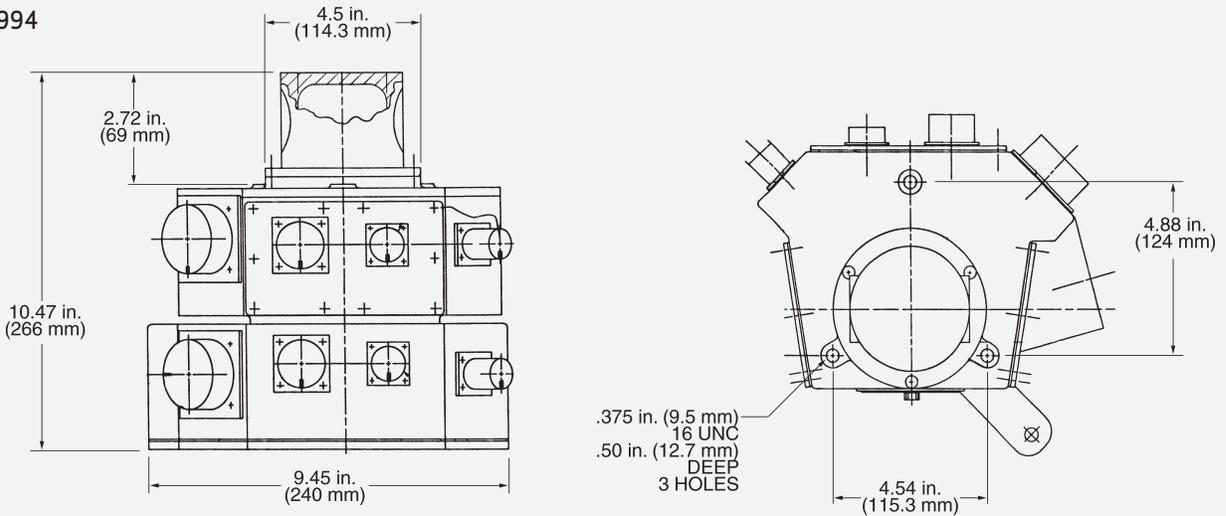
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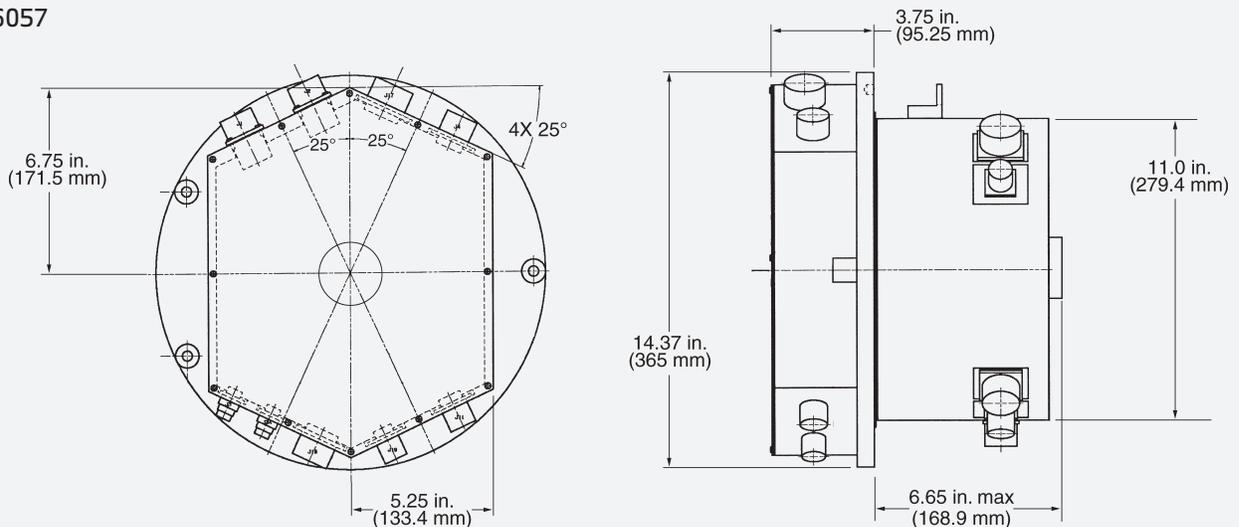
VSR-4906



VSR-4994



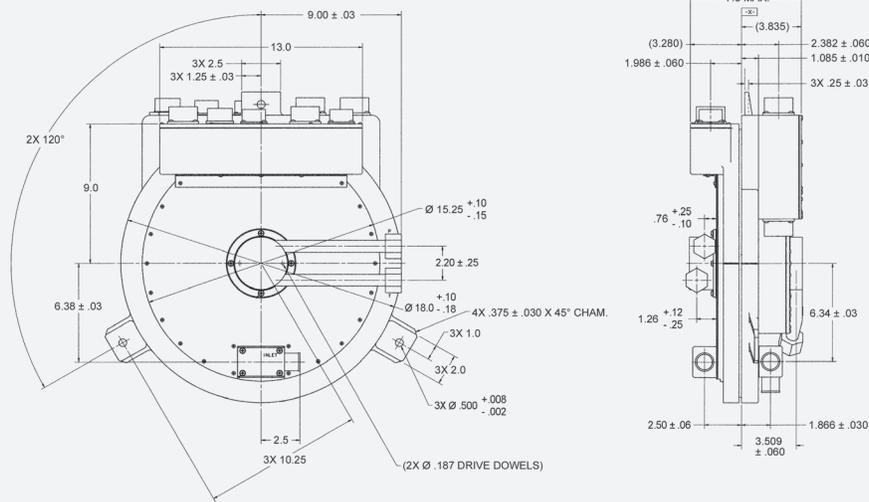
VSR-6057



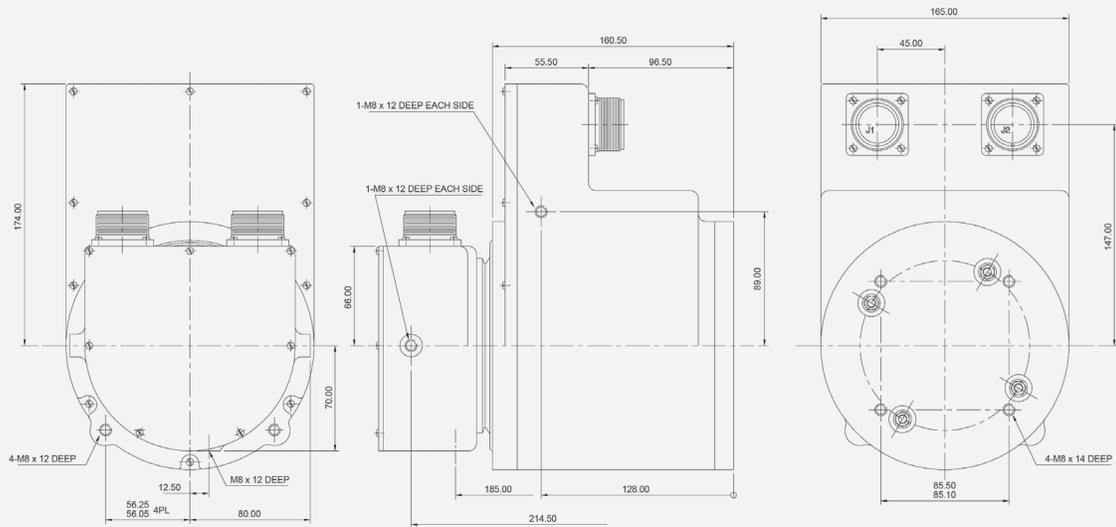
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## MECHANICAL DIMENSIONS INCHES (MILLIMETERS)

VSR-6772



VSR-2000



VSR-7001

