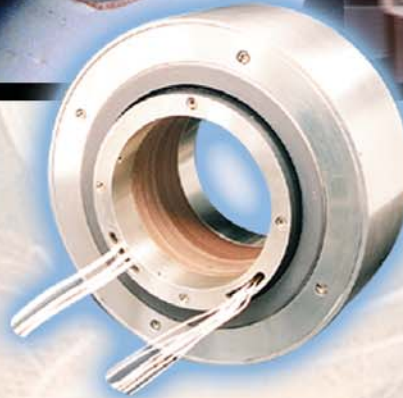


# Motion Technology Catalog

*Slip Rings • Fiber Optic Rotary Joints*



**MOOG**  
COMPONENTS GROUP



***Your work demands  
the right moves.***

**Moog Components Group** is a premier technology company with unique design and manufacturing capabilities in electromechanical and fiber optic products. Founded in 1953, the company's original vision was to become a research and development business offering new technologies for the then emerging inertial navigation marketplace for aircrafts. Quickly, it evolved into a manufacturing operation where its many innovative designs were crafted into products.

Moog Components Group has a legacy for providing high-quality products used in critical defense and space applications. Over the years, this foundation has expanded to a broad spectrum of commercial markets, including medical, industrial automation and communications. The company is ISO certified and utilizes world-class manufacturing strategies, including Six-Sigma and Lean Manufacturing, that allow the company to produce the highest quality products at competitive prices.

Today, Moog Components Group's core business is motion technology and fiber optics. Product lines include slip rings, motors, resolvers, actuators and fiber optic components. There are operations in Blacksburg, Va; Murphy, N.C.; Springfield, Pa; and Brno, Czech Republic. There are over 1,000 employees worldwide.

Moog Components Group offers standard and custom solutions for use in commercial, industrial, medical, aerospace and defense applications. More information about Moog Components Group and its products are available at [www.moog.com](http://www.moog.com).

"Our success is attributed to the ideas, skills and dedication of our employees. Over the past 50 years, these fine individuals have conquered new markets and built a company that today has a diverse portfolio of applications that range from slip rings used in medical imaging (CT Scan) applications to fiber optic switches used in shipboard communication systems. Our customers, our suppliers, our employees and our community - that's what it's all about at Moog Components Group."  
*Larry Ball, vice president and general manager*

***We have the motion solutions.***



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**Application Engineering Assistance**  
800-336-2112 • 540-552-3011

**Sales Assistance**  
800-336-2112 • 540-552-3011

**Literature Request**  
800-336-2112 ext. 279 • 540-552-3011 ext. 279  
mcg@moog.com

## We have your motion application solutions.



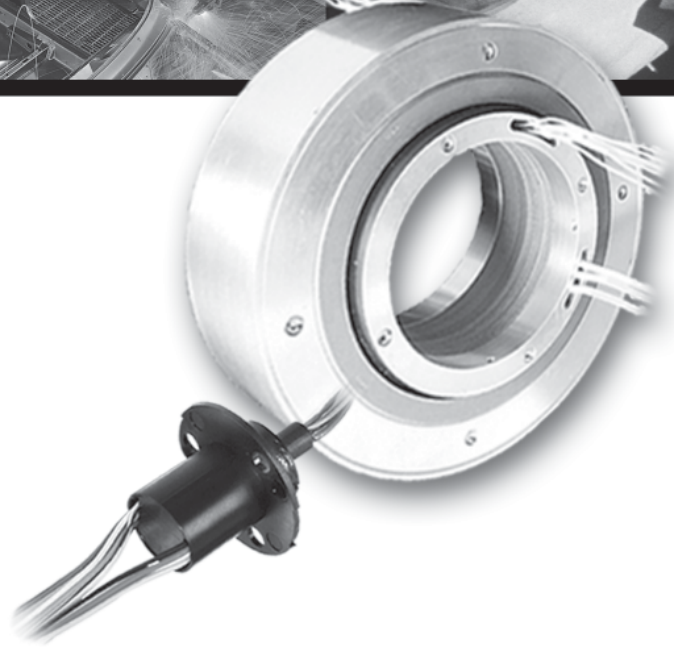
### Typical Applications

#### Commercial

- Robotics
- Index tables
- Semiconductor handling
- Pan tilt camera mounts
- Packaging equipment
- Cable reels
- Medical equipment

#### Aerospace / Military

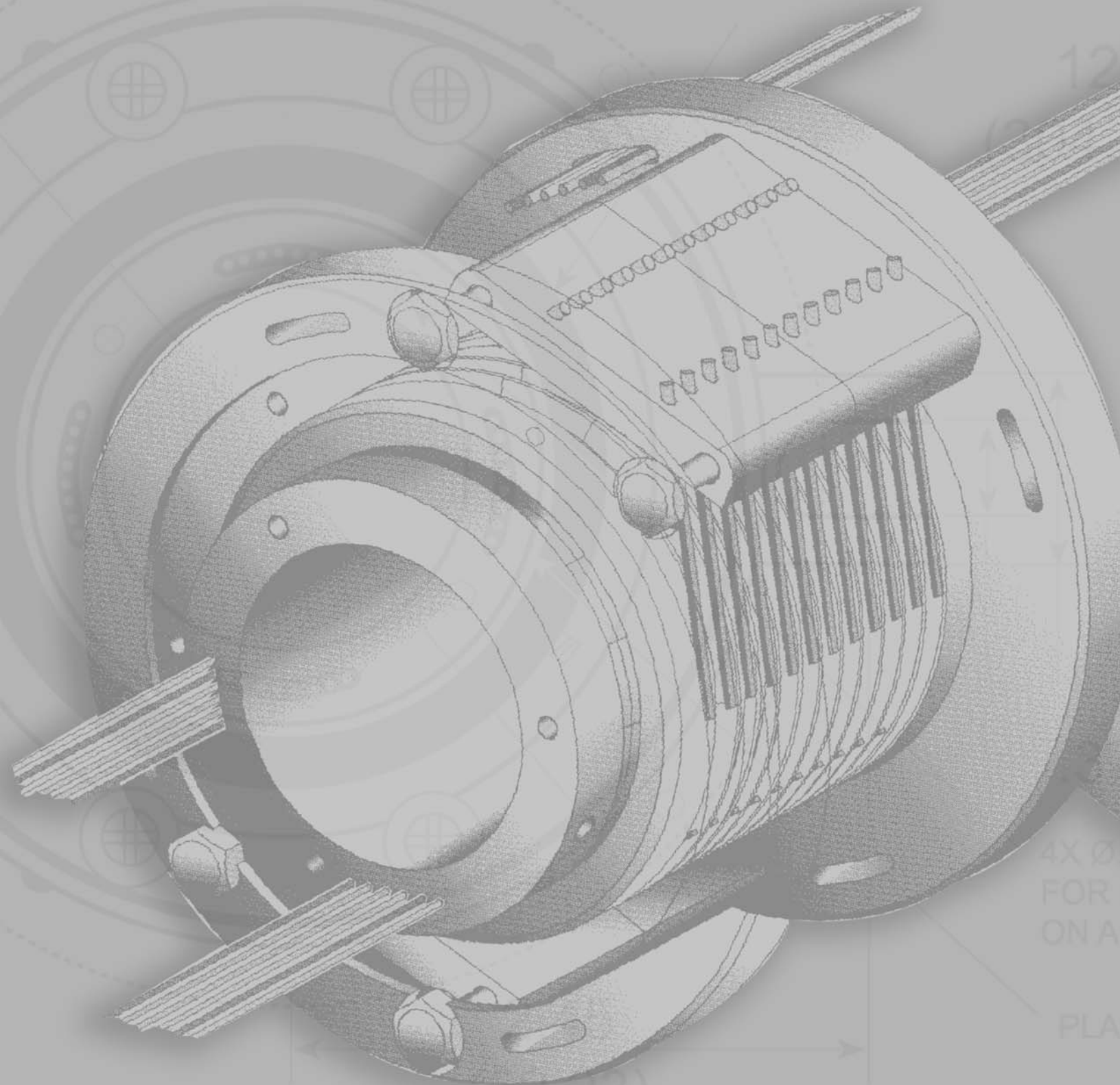
- Military vehicle turret, IR and EO systems
- Missile seeker gimbals and inertial systems
- Helicopter de-ice systems, EO / IR trackers and target systems
- Fixed-wing aircraft - EO / IR trackers, fire control systems, surveillance systems and targeting systems
- Missile counter measures
- Space - solar array mechanisms
- Shipboard / submersible - navigating systems and fire control radar
- Surveillance systems



**MOOG**  
COMPONENTS GROUP

# Selecting A Slip Ring

WITH TWO #6-32 SET-SCREWS FOR SHAFT MOUNTING



4X Ø  
FOR  
ON A

PLA

(02.23)

OPTIONAL 5.0 O.D. (127 O.D.) FLANGE WITH FOUR .215 DIA (5.4610) MOUNTING HOLES, EQUALLY SPACED ON A 4.0 (101.6) DIA SLIPS OVER THE PLASTIC COLLAR FOR

# How To Specify A Slip Ring

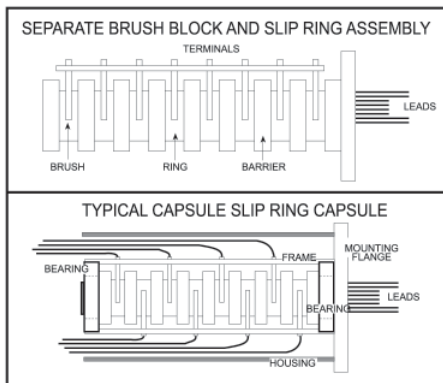
Many of the more than 6,000 slip ring designs are available for use in their existing configuration or they may be modified to meet your specific requirements. New designs can also be created to meet the most demanding specifications.

Our engineers are experienced in a wide range of slip ring applications. A very active in-house quality program solicits the best inputs from all of our many concurrent engineering groups, from start to finish.

This section is designed to guide you through the process of specifying a slip ring. We've outlined below the major considerations that a slip ring engineer will need to know about your application.

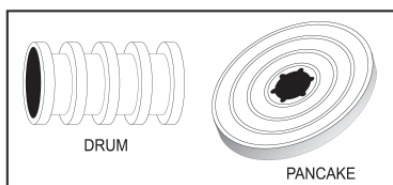
## Basic Slip Ring Design

Throughout these pages, you will see the terms "**slip ring capsule**" and "**slip ring separates**". The term "**separate**" indicates an individual rotor/brush block combination. The term "**capsule**" is used to denote a self-contained unit consisting of a rotor, stator and its own integral ball bearings.



There are two basic slip ring configurations to consider based on space allocation in your system:

1. the more common drum approach where each ring is adjacent to the next along the centerline, somewhat like the threads on a bolt, and
2. the pancake approach where the rings are concentric with one another like the grooves on a phonograph record. The pancake approach is used when length is at a premium but diameter is less restrictive.



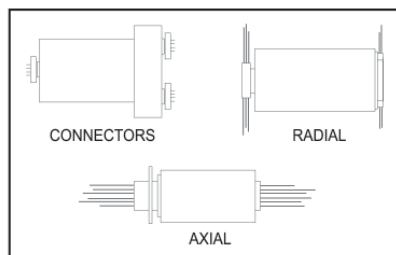
## Defining the Mechanical Envelope

The envelope is, of course, largely dictated by the space available in the system. The slip ring engineer should be given the maximum space available in the system so all existing candidate designs can be considered. It is imperative that the space required for the slip ring be specified in the early stages of the system design and that it be consistent with the structural and electrical demands.

## Defining System Interface Requirements

The slip ring engineer will need to know these system interface considerations:

1. Is a bore required through the slip ring for routing coolant plumbing, hydraulic lines, pneumatic lines, waveguides, etc? In such applications, the slip ring actually mounts concentric with these lines in the system.
2. How will the slip ring attach to the system? It is never advisable to hard mount both the rotor and the stator to the system since the slip ring bearings may overload if there is any misalignment between them and the system bearings.
3. How should the electrical connections to the slip ring be made? Is it desirable to have connectors integral with the slip ring on both the rotor and stator, or would flying leads on one or the other ends be desirable? And if flying leads are preferred, should they exit the rotor/stator in a radial or axial direction, and what length should the leads be?



## Defining Electrical Requirements

The specified current enables the slip ring engineer to propose a unit with the appropriate cross-sectional area of the rings, brushes and lead wires. The specified voltage dictates the spacing between adjacent rings and brushes. It is helpful in achieving the most cost effective and smallest practical envelope not to rate all circuits at the maximum level. For example, if you need 20 circuits total, three of which must carry ten amps, designate three for high current. Don't insist on 100% functional interchangeability by specifying that all 20 circuits carry ten amps. And, if ten amps is a surge current with a continuous current of only two amps, tell us that, too. There is no reason for you to

pay for ten amps continuous capacity when you only need two.

Be aware that voltage surges and spikes are the major cause of system slip ring failures. Moog Components Group uses a conservative approach to circuit design, however, it is not uncommon in some power supply systems to see voltage spikes ten or more times the normal operating voltage. We strongly recommend surge protection on all power supplies.

Most smaller slip rings will satisfactorily conduct signals to 50 megabits/sec. Special slip rings can be used to pass broadband signals from dc to 1 gigahertz and data rates of 500 megabits or even higher. Cross-talk, insertion loss and bit error rate information can be provided if data rates, formats and impedances are defined. The appropriate shielding techniques will be incorporated to meet the system requirements.

## Defining Mechanical Requirements

1. Operating speed (rpm's) is an important design parameter. Almost any slip ring can operate successfully at speeds to 100 rpm although many applications only require operation at a few rpm. Slip rings are routinely used to instrument test jet turbine engines operating at speeds in excess of 20,000 rpm. The operating speed, in conjunction with the diameter, dictates the surface speed of the ring relative to the brush and hence the internal design approach and material selection.
2. What rotational life is necessary for your application? Will the unit oscillate or rotate at a continuous speed?

## Defining the Environment

The environment in which the slip ring must survive is a key factor. Operating temperature range is important in specifying the proper lubricant. And if the slip ring will operate exposed to the elements or to a hostile environment, integral seals must be included in the design. Any unusual shock or vibration should also be specified.

## Your Slip Ring Requirements

For assistance on your slip ring requirements, please complete the *Slip Ring Application Specification Sheet* located on page 7, you can either fax or call and speak with one of our engineers about your best slip ring solution.

Many of the slip ring designs and manufacturing processes described are proprietary and are covered under one or more U.S., European or Japanese patents. The information provided is intended to assist the system engineer in initial discussions and is not intended as a specification.

# Slip Ring Application Specification Sheet

Date \_\_\_\_\_ Salesperson \_\_\_\_\_

Please supply as much accurate information as possible about your requirements to assist our Engineering and Sales staff in assessing the best possible solution to your application.

## COMPANY INFORMATION

Company Name	Contact
Division	<input type="checkbox"/> Buyer
Address	<input type="checkbox"/> Engineer
	<input type="checkbox"/> Other _____
City	State Zip
Phone	FAX
	E-mail

1) Description of Application: \_\_\_\_\_  Commercial  
 \_\_\_\_\_  Military  
 \_\_\_\_\_  Industrial  
 \_\_\_\_\_  Other

2) Type of Slip Ring  Capsule  Separate Brush Block  Other \_\_\_\_\_  
 Separate Slip Ring  Poly-Twist (for ± °) \_\_\_\_\_

3) This Application is:  New  Retrofit / Replacement

Current Supplier: \_\_\_\_\_ Part Number: \_\_\_\_\_

4) Estimated Annual Quantity: \_\_\_\_\_ Price Target: \_\_\_\_\_ Production Start Date: \_\_\_\_\_  
 Estimated Life of Program: \_\_\_\_\_ Tooling \$ Available: \_\_\_\_\_

5) Size Constraints - Mechanical and additional requirements (i.e. resolver, motor, hydraulics, pneumatics, optical channel, etc):  
 \_\_\_\_\_  
 \_\_\_\_\_

6) Specifications:

Number of Rings: \_\_\_\_\_

Size: Length \_\_\_\_\_  
 Diameter \_\_\_\_\_  
 Bore \_\_\_\_\_

Wear (Life): Hours (or Yrs) \_\_\_\_\_  
 at Duty Cycle \_\_\_\_\_

Operating Temp Range (°C):  
 Min \_\_\_\_\_ Max \_\_\_\_\_ Norm \_\_\_\_\_

Pressure: Norm \_\_\_\_\_ Min \_\_\_\_\_

Vibration: \_\_\_\_ g's @ \_\_\_\_ Hz Shock \_\_\_\_ g's

Sealing:  None  Dust  
 Water Spray  Submersion

Rotational Speed: Norm \_\_\_\_\_  
 Max \_\_\_\_\_

Oscillatory Motion: Yes \_\_\_\_\_ No \_\_\_\_\_

Torque: Max Starting \_\_\_\_\_ gm-cm

Weight (Max): \_\_\_\_\_

Lead Length: Rotor \_\_\_\_\_ Stator \_\_\_\_\_

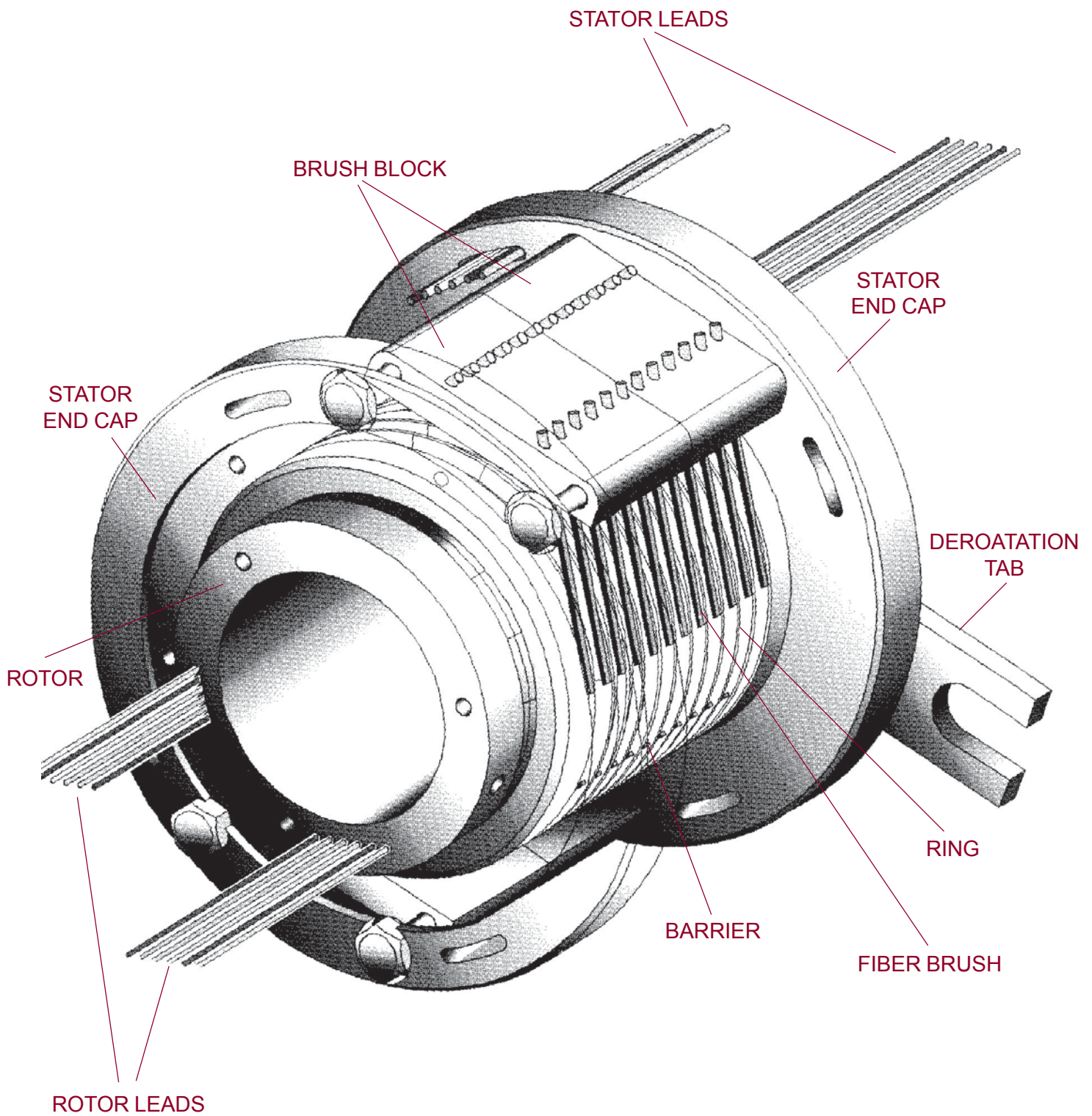
Connectors: Rotor \_\_\_\_\_ Stator \_\_\_\_\_

Load Exits: Rotor Axial \_\_\_\_\_ Radial \_\_\_\_\_  
 Stator Axial \_\_\_\_\_ Radial \_\_\_\_\_

Circuit Function	No. Ring	Current (amps)		Working Volts	Digital Risetime* or Freq. (Hz)	Crosstalk Isolation (dB)
		Normal	Max			

\*If unknown please specify protocol or data rate.

# Components Of A Slip Ring





# Commercial Slip Ring Specification Matrix

Part #	# Rings	Continuous Current (amps)						Signal		Standard Operating Voltage (AC)				Size DIA" x LG"	Bore DIA"	Rated Speed RPM	Page #
		2	5	10	15	30	50	RG178	RG179	120	240	440	600				
AC6373-6	6	6								X				.5 x .8		100	28
AC6373-12	12	12								X				.5 x 1.07		100	28
AC6023-6	6	6									X			.87 x 1.14		250	30
AC6023-12	12	12									X			.87 x 1.41		250	30
AC6023-18	18	18									X			.87 x 1.68		250	30
AC6038-24	24	24									X			.87 x 1.95		250	-
AC6305-6	9	6	3								X			.87 x 1.95		250	36
AC6305-9	12	9	3								X			.87 x 1.95		250	36
AC6305-12	15	12	3								X			.87 x 1.95		250	36
AC6310-3	6	3		3							X			.87 x 1.95		250	36
AC6310-6	9	6		3							X			.87 x 1.95		250	36
AC6355-36	36	36									X			1 x 2.6		250	32
AC6355-36V	32	28	4								X			1 x 2.6		250	32
AC6355-36X	24	20		4							X			1 x 2.6		250	32
AC6355-36C	26	20	4					2			X			1 x 2.6		250	32
AC6355-36K	26	20	4						2		X			1 x 2.6		250	32
AC6355-56	56	56									X			1 x 3.5		250	32
AC6355-56V	52	48	4								X			1 x 3.5		250	32
AC6355-56X	44	40		4							X			1 x 3.5		250	32
AC6355-56C	46	40	4					2			X			1 x 3.5		250	32
AC6355-56K	46	40		4				2			X			1 x 3.5		250	32
EC4294	2@1 amp										X			1.2 x 7.5		10,000	-
EC3848-6	6@1 amp										X			1.2 x 7.5		10,000	38
EC4199	8@1 amp										X			1.2 x 7.5		10,000	-
EC3848-10	10@1 amp										X			1.2 x 7.5		10,000	38
AC6438-6	6		6								X			2.1 x 1.6	.5	250	12
AC6438-12	12		12								X			2.1 x 2.1	.5	250	12
AC6438-18	18		18								X			2.1 x 2.7	.5	250	12
AC6438-24	24		24								X			2.1 x 3.2	.5	250	12
AC6349-6	6				6							X		3.07 x 2.9	1	250	14
AC6349-12	12				12							X		3.07 x 4.1	1	250	14
AC6349-18	18				18							X		3.07 x 5.3	1	250	14
AC6349-24	24				24							X		3.07 x 6.5	1	250	14
AC4598-6	6			6									X	3.9 x 2.13	1.5	250	16
AC4598-12	12			12									X	3.9 x 3.07	1.5	250	16
AC4598-18	18			18									X	3.9 x 4.01	1.5	250	16
AC4598-24	24			24									X	3.9 x 4.94	1.5	250	16
AC6200-12	12	12									X			3.9 x 2.13	1.5	250	18
AC6200-24	24	24									X			3.9 x 3.07	1.5	250	18
AC6200-36	36	36									X			3.9 x 4.01	1.5	250	18
AC6200-48	48	48									X			3.9 x 4.94	1.5	250	18
AC6200-6P/12S	18	12		6							X (2A)	X (10A)		3.9 x 3.07	1.5	250	18
AC6200-6P/24S	30	24		6							X (2A)	X (10A)		3.9 x 4.01	1.5	250	18
AC6200-6P/36S	42	36		6							X (2A)	X (10A)		3.9 x 4.94	1.5	250	18
AC6200-12P/12S	24	12		12							X (2A)	X (10A)		3.9 x 4.01	1.5	250	18
AC6200-12P/24S	36	24		24							X (2A)	X (10A)		3.9 x 4.94	1.5	250	18
AC6200-18P/12S	30	12		12							X (2A)	X (10A)		3.9 x 4.94	1.5	250	18
AC6419		IP65 sealed with any circuit combination of the above AC4598 or AC6200 products.											3.9 x 2.3 - 5.1	1.5	250	-	
AC6428-060	60	60									X				1.375	250	20
AC6428-072	72	72									X			3.9 x 7.5	1.375	250	20
AC6428-084	84	84									X				1.375	250	20
AC6428-096	96	96									X			3.9 x 9.34	1.375	250	20
AC6429-006	54	48		6							X (2A)	X (10A)		3.9 x 7.5	1.375	250	20
AC6429-012	60	48		12							X (2A)	X (10A)		3.9 x 7.5	1.375	250	20
AC6275	UP TO 144		X	X		X	X						X	6.63 x 6.6 - 20.5	2.75	1000	24
AC6098	UP TO 72			X		X	X						X	8.0 x 4.6 - 14.4	4	250	26

Note: Higher speed options available for AC4598, AC6200 and AC6349.

# Aerospace / Military Slip Ring Program Matrix

SIG CKTS = Signal Circuits (Rings)  
PWR CKTS = Power Circuits (Rings)

Program	Model	Description	Key Features
Bradley Fighting Vehicle	FL4999	Commander's Independent Viewer AZ Slip Ring	Resolver, 259 SIG CKTS
	JZ4994	A3 Turret Slip Ring	Air Channel, 86 SIG CKTS & 4 PWR CKTS
	JZ4049	AZ Turret Slip Ring	Air Channel, Encoder, 42 SIG CKTS & 2 PWR CKTS
Advanced Targeting Pod	DW6410	Pitch Axis Slip Ring	45 CKT With In-board Connectors
	DW6464	Roll Axis Slip Ring	20 PWR CKTS, 3 Twinax High Speed Data Circuits (250 Mbps), 46 SIG CKTS
AH-64A/D Apache Longbow Attack Helicopter	DW4806-1	Slip Ring RF Rotary Joint Assembly	6 PWR CKTS: 115 VAC, 4 A; 73 SIG CKTS: 100 V 1 A; Resolver, 4 Channel RF Rotary Coupler
AH64 Apache	FL3091	Tail Rotor De-ice	2 PWR CKTS 20 A
Avenger Air Defense System	TX6209	Turret Slip Ring Capsule	Air Channel, Encoder Mount, 2 PWR CKTS 150 A, 28 VDC 61 SIG CKTS 3 A, 28 VDC
Blackhawk and Seahawk	AW2876	Blackhawk Main Rotor	3 Low PWR CKTS, 5 A, 28 VDC 3 Ø PWR CKTS, 60 A, 200 VAC
	AW3018	UH60 Tail Rotor	3 Ø PWR CKTS, 20 A, 200 VAC
	AW4101	Seahawk Main Rotor	3 Ø PWR CKTS, 60 A, 200 VAC; 28 VDC, 5 A
	AW6018	Blackhawk Tail Rotor	3 Ø PWR CKTS, 20 A, 200 VAC, Separate Cables
F-14 / 15 / 16 LANTIRN	DW6262-02	Main De-roll Slip Ring	Dual Axis Rotating (Spin-Despin) Hydraulic Channel 50 PWR CKTS, 130 SIG CKTS, 2 High Voltage (150 V)
Sentinel Radar	FL4189	Pedestal Slip Ring Capsule	6 PWR CKTS - 3 Ø, 208 VAC, 10 A 73 SIG CKTS
V-22 Osprey	AC6094-1	Main Prop Rotor Slip Ring De-ice and Flight Controls	14 PWR CKTS 115 VAC, 1-75 A; 49 SIG CKTS; Resolver; Redundant Bearings; Bearing Failure Sensor
Stryker IAV Mobile Gun System	ED6405	Turret Slip Ring Assembly	Hydraulics, Breathing Air, Resolver, R/D COH Version, Two High PWR CKTS, 450 A 2 Low PWR CKTS - 75 A, , 135 SIG CKTS Including 100 Mbps - Ethernet RS170 Video
Expeditionary Fighting Vehicle	ED6370	Turret Slip Ring Assembly	2, 250 A; 8, 120 A; 6, 15 A; 111, Signal; Clean Air Channel FDDI, CAN BUS and RS170 Channels
F35 Joint Strike Fighter	DW6720	EOTS Roll Slip Ring	4 PWR CKTS - 220 VAC, 2 A; 32 - SIG CKTS and GRNS
S92 Helicopter	AW6441	Main Rotor De-ice Slip Ring	3 Ø PWR CKTS 60 A, 200 VAC 10 SIG CKTS, Redundant BRGS
	AW6442	Tail Rotor De-ice Slip Ring	3 Ø PWR CKTS with Ground 20 A, 200 VAC
AWACS	JD2480	Main Power and Signal Transfer Slip Ring / RF Rotary Joint	16 PWR CKTS - 60 A, 208 VAC; SIG 110 CKTS - 5 A, 200 VAC
	JD6430	Main Power and Signal Transfer Slip Ring / RF Rotary Joint	16 PWR CKTS - 60 A, 208 VAC; SIG 110 CKTS - 5 A, 200 VAC
AIM-9X Missile	CJ6706	Seeker De-roll Slip Ring / BB Separates	PWR: 2 PWR CKTS - 28 V, 2 A; SIG: 8 SIG CKTS - 28 V, 1 A

# Commerical Slip Ring Products



# Slip Rings With Through-Bores

## AC6438

### *1/2" Bore Miniature Slip Ring Capsule Family*

#### Description

A slip ring capsule can be used in any electromechanical system that requires unrestrained, intermittent or continuous rotation while transferring power and / or data. A slip ring is also called a rotary electrical joint, collector, commutator or swivel. A slip ring can improve system performance by simplifying operations and eliminating damage prone wires.

The AC6438 provides an economical, readily available solution when a compact through bore configuration is required. This unit provides a 1/2" through-bore for routing of hydraulic or pneumatic lines, and a compact 2.1" outside diameter and a very short overall length for minimal space applications. The AC6438 provides 5 amp circuits in 6, 12, 18 and 24 ring configurations. Similar in design to our very popular AC4598 and AC6200 series, this design features long life, fiber brush contact technology for ultimate performance in many challenging applications.

#### Features

- 1/2" through-bore
- Compact 2.1" outside diameter
- Speeds up to 250 rpm continuous
- Multiple circuit configurations
- Continuous rotation of power and / or data signals
- High-impact thermoplastic construction

#### Benefits

- Transfers power, as well as analog and digital signals
- Compatible with data bus protocols
- Fiber brush technology provides long life and maintenance free operation
- Compact packaging

#### Over 6,000 designs

That's how many slip rings we've designed, so if this one's not right for your application, call us and tell us your specifications.



#### Typical Applications

- Precision rotary equipment
- Semiconductor handling systems
- Industrial machinery
- Robotics

# Slip Rings With Through-Bores

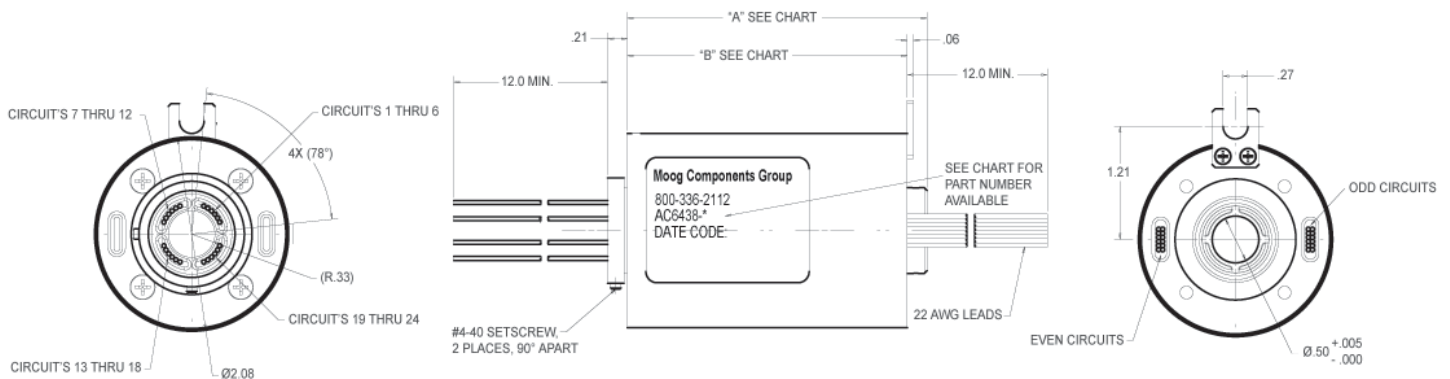
Specifications	
Operating Speed	250 rpm*
Number of Circuits	6, 12, 18 or 24
Lead Length	12 inch standard
Voltage	250 AC / DC
Current Rating	5 amps / circuit
Lead Size / Type	22 AWG, 7 strand
Operating Temp.	80°C
Noise	Less than 60 milliohms

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

Wire Color Code					
Ring #	Color	Ring #	Color	Ring #	Color
1	BLK	9	GRY	17	WHT / BLU
2	BRN	10	WHT	18	WHT / VIO
3	RED	11	WHT / BLK	19	WHT / GRY
4	ORN	12	WHT / BRN	20	WHT / BLK / BRN
5	YEL	13	WHT / RED	21	WHT / BLK / RED
6	GRN	14	WHT / ORN	22	WHT / BLK / ORN
7	BLU	15	WHT / YEL	23	WHT / BLK / YEL
8	VIO	16	WHT / GRN	24	WHT / BLK / GRN

Part Number	AC6438-6	AC6438-12	AC6438-18	AC6438-24
Dimension "A"	1.54 ± .020	2.10 ± .020	2.66 ± .020	3.21 ± .020
Dimension "B"	1.33 ± .010	1.89 ± .010	2.44 ± .010	3.00 ± .010

## AC6438 Dimensions



# Slip Rings With Through-Bores

## AC6349

### *1 inch through-bore various circuit configurations*

#### Description

A slip ring capsule can be used in any electromechanical system that requires unrestrained, intermittent, or continuous rotation while transferring power and / or data.

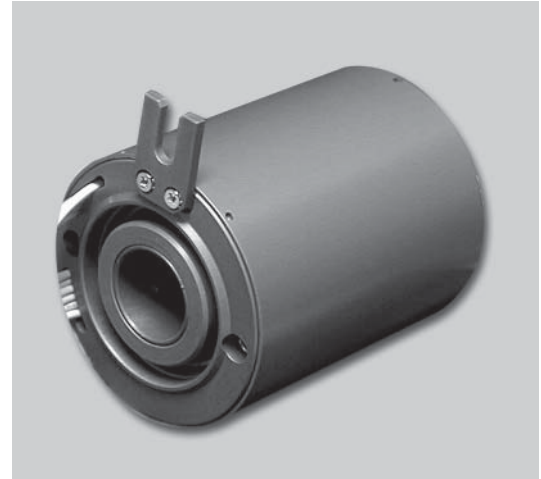
The AC6349 provides an economical, readily available solution when a compact through-bore configuration is required. This unit provides a 1 inch through-bore for routing of hydraulic or pneumatic lines, and a compact 3 inch outside diameter for minimal space applications. The 15 amp circuits are available in 6, 12, 18 and 24 ring configurations in 4 housing lengths. Similar in design to our very popular AC4598, this design features long life, fiber brush contact technology for ultimate performance in many challenging applications. Fiber brushes do not require lubrication and produce virtually no wear debris, for maintenance free, life time operation.

#### Features

- 6, 12, 18 and 24 circuit models
- Precious metal contacts
- 15 amp rings
- Precision ball bearings for long life
- Speeds up to 250 rpm continuous
- Compact size
- Sealed units available
- Flying leads
- Fully compatible with both analog and TTL control level signals
- Optional flange mounting (rotor side only)

#### Benefits

- Unique signal handling performance with minimal electrical circuit noise
- Tight packaging to fit in the most demanding space constraints
- Low torque to minimize system torque budget
- Rapid delivery



#### Typical Applications

- Packaging / wrapping machinery
- Semiconductor handling systems
- Industrial machinery
- Robotics

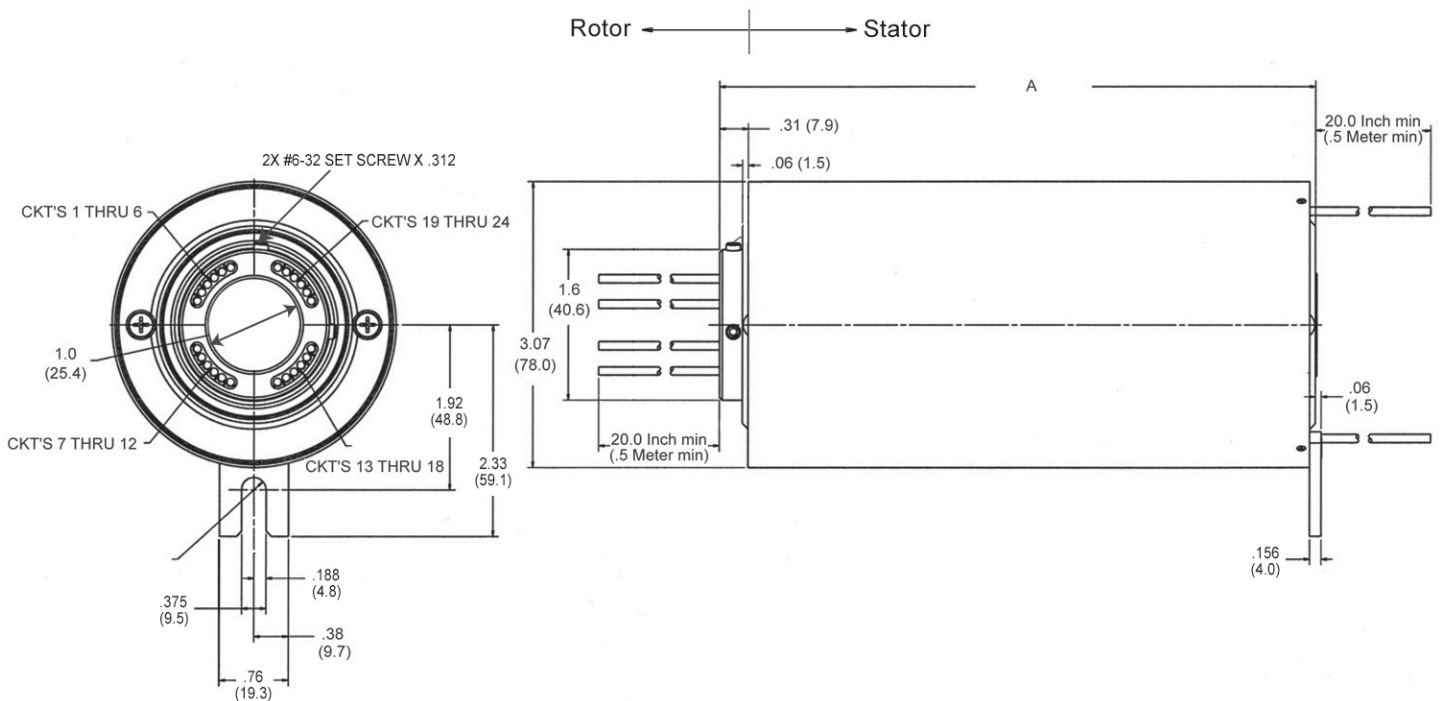
# Slip Rings With Through-Bores

Specifications		Options
Operating Speed	250 rpm*	<ul style="list-style-type: none"> <li>• Steel bearings</li> <li>• Gold - plated rings</li> <li>• Mounting flange</li> <li>• Seals</li> <li>• Long leads</li> </ul>
Number of Circuits	6, 12, 18, or 24	
Lead Length	20 inch standard	
Lead Size / Type	14 gauge, white with tags	
Voltage	440 VAC	
Operating Temp.	-40°C to +80°C	
Contact Material	Silver-on-silver	
Dielectric Strength	500 VAC @ 60 Hz, between each circuit all other circuits	
Insulation Resistance	1000 megohms max tested 500 VAC	
Circuit Resistance	200 milliohms with 12 inch leads	
Electrical Noise	60 milliohms max @ 6 VDC 50 milliamps when running @ 5 rpm	
Environmental	Splash and dust seal optional	
Flange	4.5" OD x .188, rotor side	

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

Part Number	Length A
AC6349 - 6	2.9 (74.2)
AC6349 - 12	4.1 (104.1)
AC6349 - 18	5.3 (149.7)
AC6349 - 24	6.5 (165.1)

Standard units are not sealed.



# Slip Rings With Through-Bores

## AC4598

10 amp per circuit 1-1/2 inch through-bore

### Description

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and / or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, collector, swivel, or a rotary joint. A slip ring can improve system performance by simplifying operations and eliminating damage-prone wires dangling from movable joints.

The 1-1/2 inch through-bore provides routing space for hydraulics, pneumatics or for a concentric shaft mount.

The AC4598 uses our unique fiber brush technology which offers several advantages over conventional slip ring contacts, including multiple points of contact per brush bundle, low contact force per fiber, low noise and low contact wear rates. In addition, fiber brushes do not require lubrication and produce virtually no wear debris.

### Features

- 1-1/2 inch through-bore
- Speeds up to 250 rpm continuous
- 6, 12, 18 or 24 ten amp circuits
- 16 gauge, 12 inch lead wire - longer lead lengths are available
- Higher rotational speeds with alternate bearings (optional)
- Various axial and radial lead exits are available
- Splash seals for dust and moisture resistance
- Standard collar mounting - flange mounting optional
- Also available with 12, 24, 36 and 48, 2 amp rings or power and signal combinations. Please refer to AC6200 data sheet.

### Benefits

- Transfers analog and digital signals
- Compatible with data bus protocols
- Fiber brush technology provides long life and maintenance-free operation (no lubrication required)
- Continuous 360° rotation of power or data signals



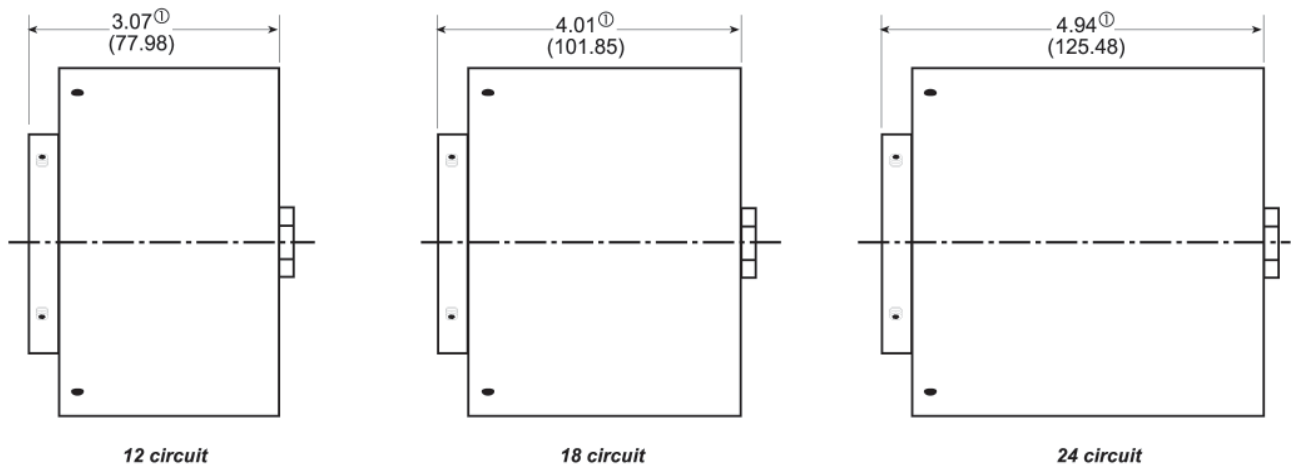
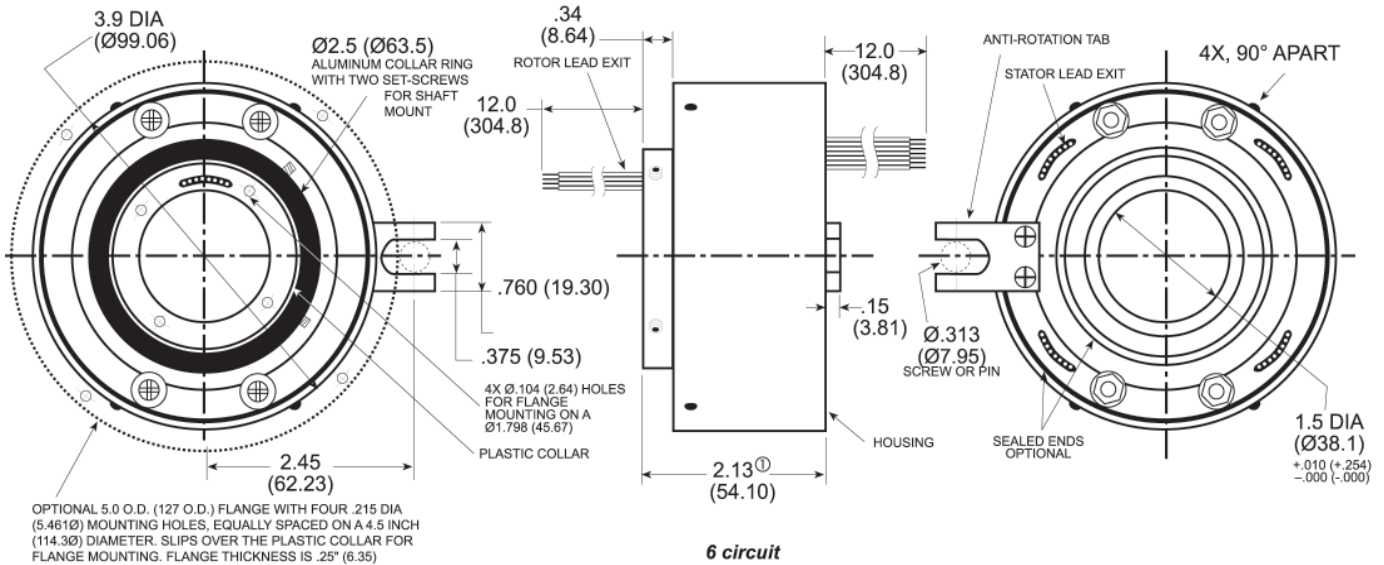
### Typical Applications

- Industrial machinery - machining centers, rotary index tables, heavy equipment turrets or cable reels, test equipment, packaging machines, palletizing machines, magnetic clutches, process control equipment, rotary sensors, emergency lighting, robotics
- Exhibit / display equipment
- Medical equipment



# Slip Rings With Through-Bores

Specifications		Options			
Operating Speed	0 - 250 rpm continuous	<ul style="list-style-type: none"> <li>• 5.0" (127mm) O.D. flange with 4 mounting holes</li> <li>• Splash seals for dust and moisture resistance</li> <li>• Various axial and radial lead exits are available</li> <li>• Longer lead lengths are available</li> <li>• Higher rotational speeds with alternate bearings</li> <li>• Higher current and voltage capacity per circuit</li> <li>• Signal and power circuit combination</li> <li>• IP 65 rated enclosure available</li> </ul>			
Number of Circuits	6, 12, 18 or 24				
Lead Wire	16 gauge, 12 inches (304.8 mm)				
Current	10 amp circuits				
Operating Temp.	-40°C to 80°C				
Voltage	600 VRMS				
Noise	Less than 100 milliohms peak @ 6 VDC, 50 mA, 250 rpm				
Torque	Approx. .5 in-oz (36.00 cm-g) per circuit unsealed				
	Add approx. 10 in-oz (720.08 cm-g) for dust seals				
Sealed Units	Intermittent splash and gross particle exclusion only				
Lead Wire Color Code					
1. Blk	5. Yel	9. Gry	13. Wht-Red	17. Wht-Blu	21. Wht-Blk-Red
2. Brn	6. Grn	10. Wht	14. Wht-Orn	18. Wht-Vio	22. Wht-Blk-Orn
3. Red	7. Blu	11. Wht-Blk	15. Wht-Yel	19. Wht-Gry	23. Wht-Blk-Yel
4. Orn	8. Vio	12. Wht-Brn	16. Wht-Grn	20. Wht-Blk-Brn	24. Wht-Blk-Grn



**Notes:**

1. Drawings not actual size, measurements are in inches (millimeters)
  2. Rotor and stator leads exit 4 places, 90° apart, 6 leads per exit relative to circuit count
- Ⓛ Flange mounted, add .188 (4.78) for flange

# Slip Rings With Through-Bores

## AC6200

*1-1/2 inch through-bore 12, 24, 36 and 48 circuit versions*

### Description

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and/or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, collector, swivel or a rotary joint. A slip ring can improve system performance by simplifying operations and eliminating damage-prone wires dangling from movable joints.

The 1-1/2 inch unobstructed through-bore provides routing space for hydraulics, pneumatics or for a concentric shaft mount.

The AC6200 uses fiber brush technology which offers several advantages over conventional slip ring contacts including multiple points of contact per brush bundle, low contact force per fiber and low contact wear rates. In addition, fiber brushes do not require lubrication and produce virtually no wear debris, for maintenance free, life time operation.

### Features

- 1-1/2 inch through-bore
- Speeds up to 250 rpm continuous
- 12, 24, 36 and 48 circuit versions with 2 amp contacts
- Power and signal (2 and 10 amp) circuits may be combined
- Shaft, brush block and cover are molded of high-impact thermoplastic
- Optional steel bearing and splash seals for harsh environments (special order)
- Collar mounting is standard; flange mounting optional
- 26 gauge color coded, 12" lead wires
- Continuous 360° rotation of power or data signals
- Also available with 6, 12, 18 and 24, 10 amp rings. Please refer to AC4598 data sheet.

### Benefits

- Transfers control and data signals
- Fiber brush technology provides maintenance-free operation (no lubrication required)
- Modular design meets special requirements through off-the-shelf manufacturing techniques
- Compact packaging



### Typical Applications

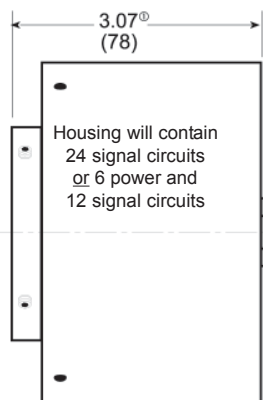
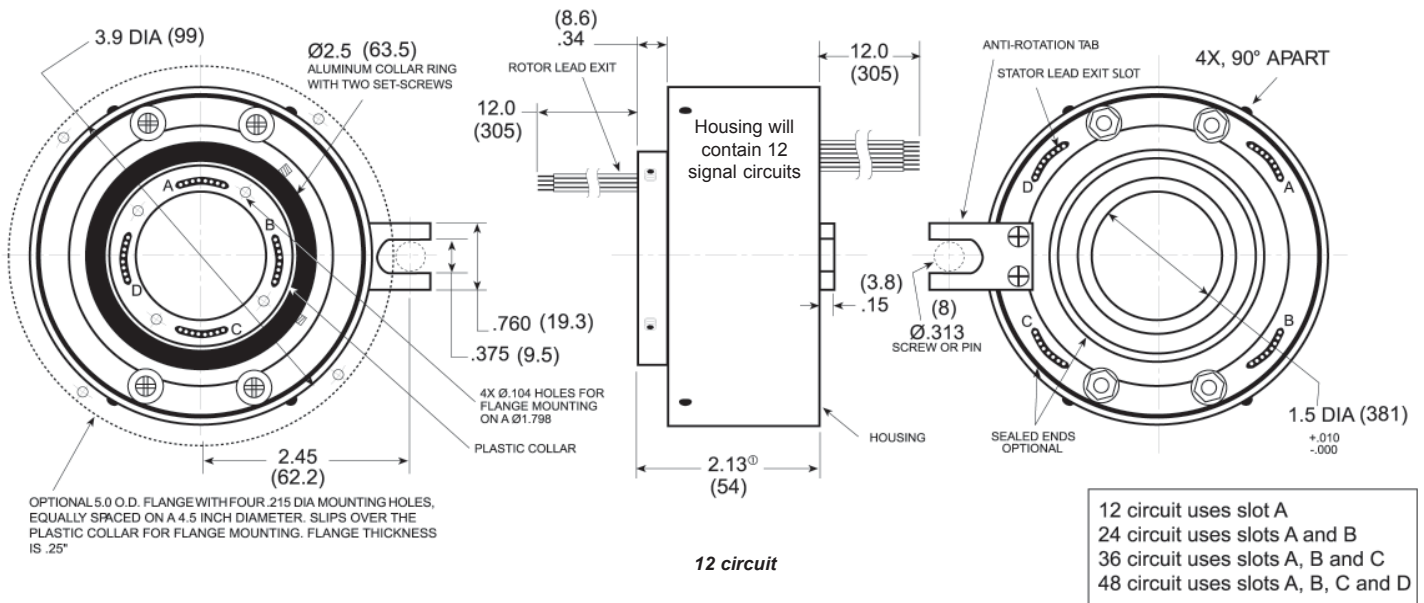
- Industrial machinery – machining centers, rotary index tables, heavy equipment turrets or cable reels, test equipment, packaging and palletizing machines, magnetic clutches, process equipment, rotary sensor, emergency lighting, robotics
- Exhibit / display equipment
- Medical equipment

# Slip Rings With Through-Bores

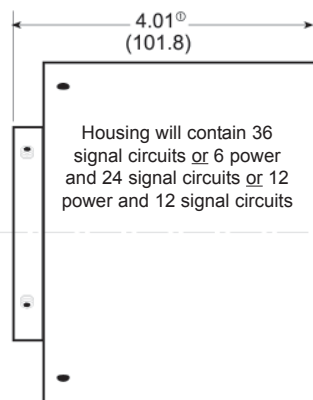
Specifications		Options
Operating Speed	0 - 250 rpm continuous	<ul style="list-style-type: none"> <li>• 5.0" O.D. flange with 4 mounting holes</li> <li>• Splash seals for dust and moisture resistance</li> <li>• Various axial and radial lead exits are available</li> <li>• Signal and power circuit combination for</li> <li>• 2, 5 and 10 amp applications</li> <li>• Gold plated rings</li> <li>• IP 65 rated enclosure available</li> </ul>
Number of Circuits	12, 24, 36, 48	
Lead Wire	26 gauge, 12 inches	
Current	2 amps / circuit	
Operating Temp.	80°C max.	
Voltage	220 VRMS	
Noise	Less than 60 milliohms peak @ 6 VDC, 50 mA, 5 - 15 rpm	
Torque	Approx. .5 in-oz per circuit unsealed Add approx. 10 in-oz for dust seals	
Sealed Units	Intermittent splash and large particle exclusion only	

## Lead Wire Color Code

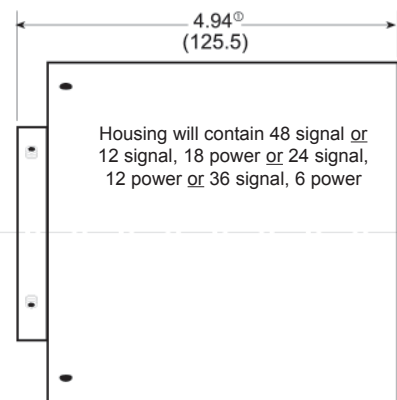
<b>A</b> 1. Blk 5. Yel 9. Gry	<b>B</b> 13. Blk 17. Yel 21. Gry	<b>C</b> 25. Blk 29. Yel 33. Gry	<b>D</b> 37. Blk 41. Yel 45. Gry
2. Brn 6. Grn 10. Wht	14. Brn 18. Grn 22. Wht	26. Brn 30. Grn 34. Wht	38. Brn 42. Grn 46. Wht
3. Red 7. Blu 11. Wht-Blk	15. Red 19. Blu 23. Wht-Blk	27. Red 31. Blu 35. Wht-Blk	39. Red 43. Blu 47. Wht-Blk
4. Orn 8. Vio 12. Wht-Brn	16. Orn 20. vio 24. Wht-Brn	28. Orn 32. Vio 36. Wht-Brn	40. Orn 44. Vio 48. Wht-Brn



24 circuit



36 circuit



48 circuit

### Notes:

Drawings not actual size, dimensions are in inches (millimeters)

Rotor and stator leads exit 4 places, 90° apart, 12 leads per exit relative to circuit count

Ⓞ Flange mounted, add .188 (4.8) for flange

# Slip Rings With Through-Bores

## AC6428

*1 3/8 inch through bore in 60, 72, 84 and 92, 2 amp circuit versions*

## AC6429

*1-3/8 inch through bore in 48, 2 amp circuits and 6 or 12, 10 amp circuits*

### Description

A slip ring capsule can be used in any electromechanical system that requires unrestrained, intermittent, or continuous rotation while transferring power and / or data. A slip ring is also called a rotary electrical joint, collector, commutator, or swivel. A slip ring can improve system performance by simplifying operations and eliminating damage prone wires.

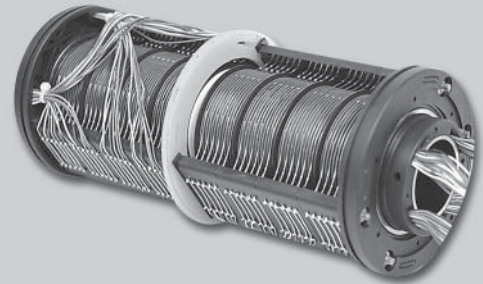
The AC6428 and AC6429 provide an economical, readily available solution when a compact, through bore configuration is required. This unit provides a 1-3/8 inch through bore for routing of hydraulic or pneumatic lines, and a compact 3.9 inch outside diameter for minimal space applications. The AC6428 provides 2 amp circuits in 60, 72, 84 and 96 ring configurations. The AC6429 provide 48, 2 amp rings coupled with either 6 or 12, 10-amp circuits. Similar in design to our very popular AC4598 and AC6200 series, this design features long life, fiber brush contact technology for ultimate performance in many challenging applications.

### Features

- 1-3/8 inch through bore
- Speeds up to 250 rpm continuous
- Multiple circuit configurations
- Continuous rotation of power and / or data signals
- High-impact thermoplastic construction
- Sealed to dust and light fluid splash

### Benefits

- Transfers power, as well as analog and digital signals
- Compatible with data bus protocols
- Fiber brush technology provides long life and maintenance free operation
- Compact packaging



### Typical Applications

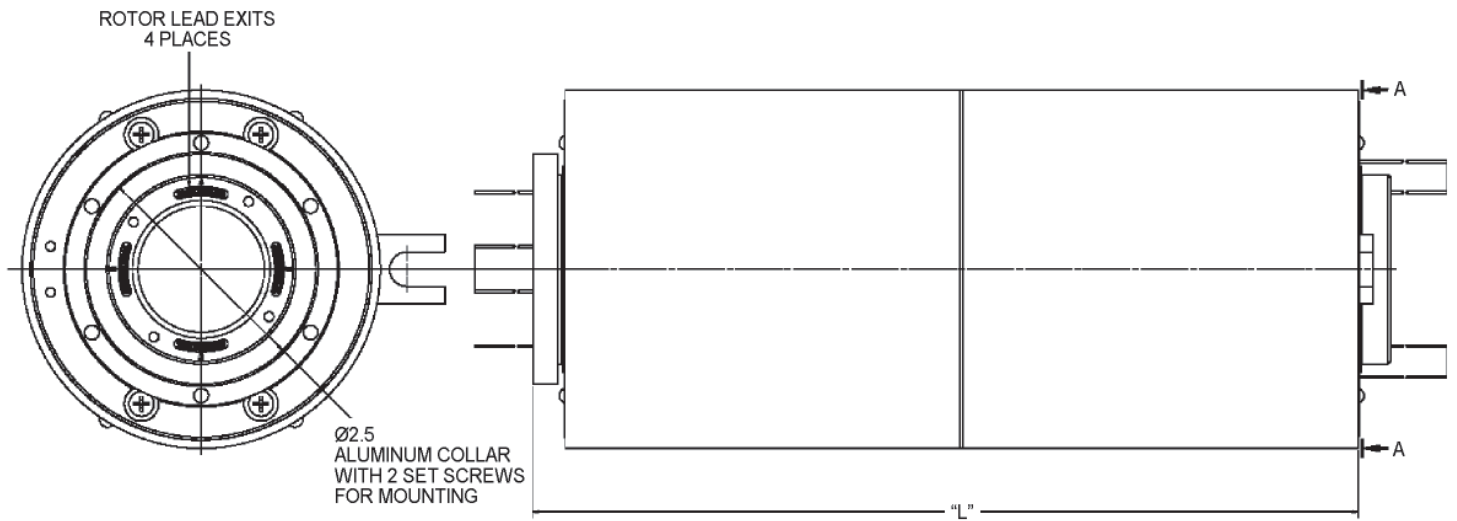
- Precision rotary equipment
- Semiconductor handling systems
- Industrial machinery
- Robotics

# Slip Rings With Through-Bores

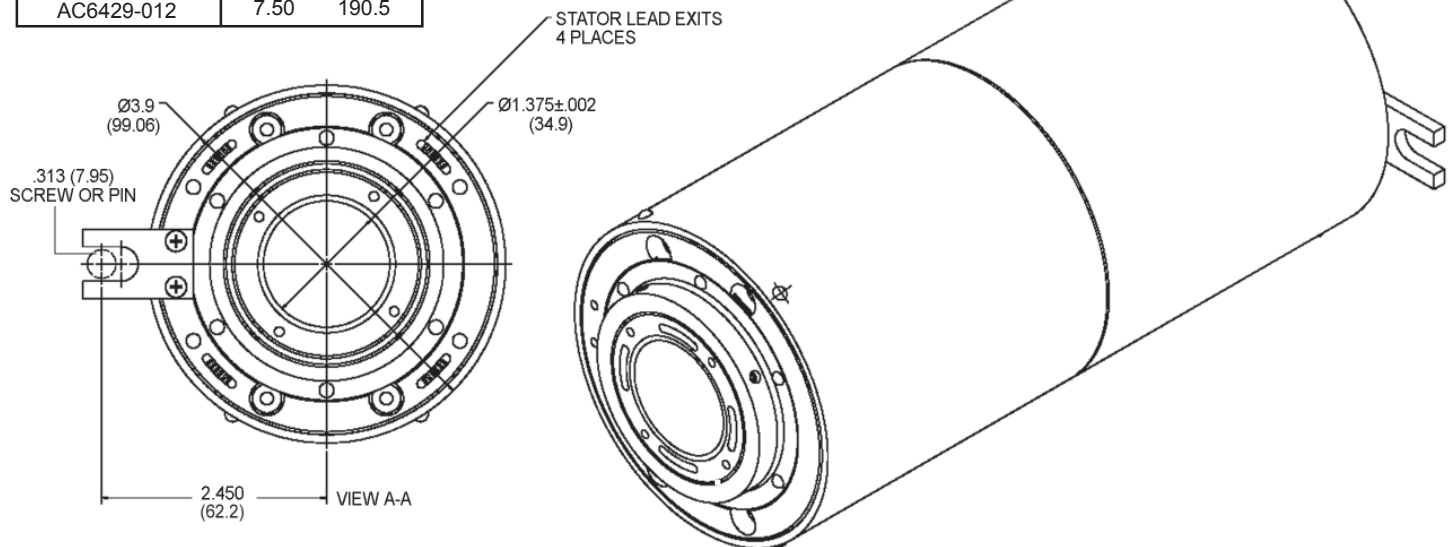
Specifications	AC6428	AC6429
Operating Speed	250 rpm	250 rpm
Number of Circuits	60, 72, 84, 96	48 @ 2 amp PLUS 6 or 12 @ 10 amp
Lead Lengths	40 inches (1000 mm)	40 inches (1000 mm)
Voltage	220 VRMS	220 VRMS, 2 amp; 460 VRMS 10 amp
Current Ratings	2 amps / circuits	10 amp and 2 amps / circuit
Lead Size / Type	26 AWG	26 AWG, 2 amp circuits 16 AWG, 10 amp
Operating Temp.	80° C	80° C
Noise	Less than 60 milliohms peak-to-peak	

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

Optional Gold Rings Available



MODEL	"L"	
	in.	mm.
AC6428-60	6.60	167.7
AC6428-72	7.50	190.5
AC6428-84	8.45	215.0
AC6428-96	9.40	239.0
AC6429-006	7.50	190.5
AC6429-012	7.50	190.5



Dimensions in inches (mm)

# Slip Rings With Through-Bores

## AC6231

### High Speed Through-bore Capsule

#### Description

A slip ring capsule can be used in any electromechanical system that requires unrestrained, intermittent, or continuous rotation while transferring power and / or data. A slip ring is also called a rotary electrical joint, collector, commutator, or swivel. A slip ring can improve system performance by simplifying operations and eliminating damage prone wires.

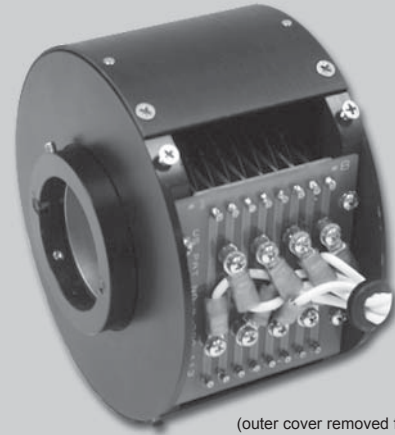
The AC6231 provides a high performance solution when a through bore configuration with high-speed operation is required. This unit provides a 1-1/2 inch through-bore for shaft mounting and a compact 4.25 inch outside diameter and very short overall length for minimal space applications. The AC6231 provides eight 15 Amp circuits. Similar in design to our very popular AC4598 and AC6200 series, this design features long life, fiber brush contact technology for ultimate performance in many challenging applications. Brush blocks are easily replaceable for extended life.

#### Features

- 1-1/2 inch through-bore
- Compact 4.25 inch outside diameter
- Speeds up to 2500 rpm continuous
- Transfers power, as well as analog and digital signals
- Rugged anodized aluminum construction

#### Benefits

- Compatible with data bus protocols
- Fiber brush technology provides long life and operation
- Compact packaging
- Ease of installation



(outer cover removed for view)

#### Typical Applications

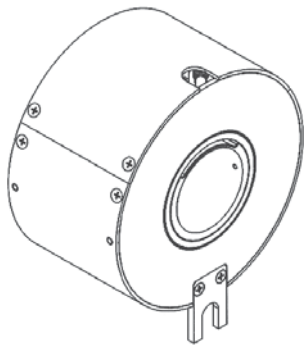
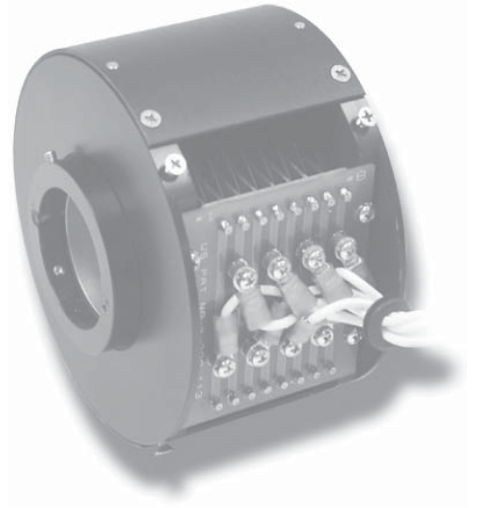
- Precision rotary equipment
- High speed testing
- Semiconductor handling systems
- Industrial machinery
- Robotics

# Slip Rings With Through-Bores

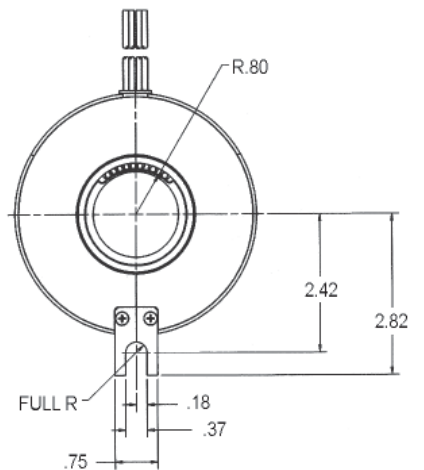
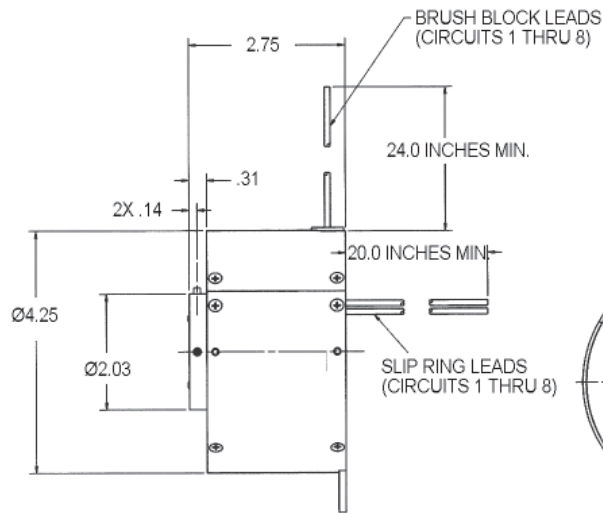
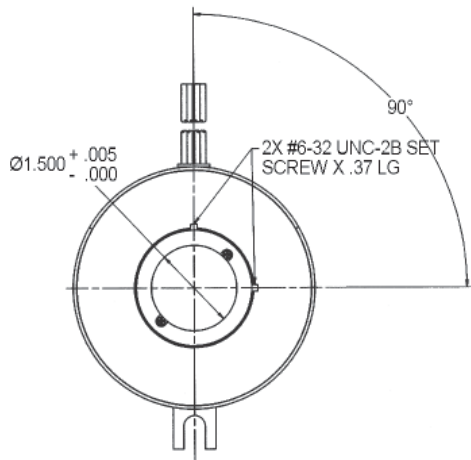
## Specifications

Operating Speed	2500 rpm*
Number of Circuits	8
Lead Lengths	20" rotor, 24" stator
Voltage	220 VRMS
Current Rating	15 amps / circuit
Lead Size / Type	14 AWG, strand (19/27) strand, UL 1213 white
Operating Temp.	80°C
Noise	Less than 60 milliohms peak-to-peak

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.



VIEW SHOWN WITHOUT LEADS AND GROMMET



# Slip Rings With Through-Bores

## AC6275

2-3/4 inch through-bore

### Description

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and/or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, collector, swivel or a commutator. A slip ring can improve system performance by simplifying operations and eliminating damage-prone wires dangling from movable joints.

The 2-3/4" unobstructed through-bore provides routing space for hydraulics, pneumatics or for a concentric shaft mount.

The AC6275 uses our patented fiber brush technology which offers several advantages over conventional slip ring contacts including multiple points of contact per brush bundle, low contact force per fiber and low contact wear rates. In addition, fiber brushes do not require lubrication and produce virtually no wear debris. The AC6275 features field serviceable brush blocks.

### Features

- 2-3/4" through-bore
- Compact 6.63" O.D.
- Modular design - a single module can have: one 50 amp ring; two 30 amp rings; one, two or three-ten amp rings; six 5 amp signals
- For a total up to 24-50 amp circuits, 48-30 amp circuits, 72-10 amp rings or 144-5 amp in a 24 module length
- Speeds up to 1,000 rpm continuous
- Steel bearings and machined shaft and housing for harsh environments
- Collar mounting is standard; flange mounting is optional
- Various lead exits are available
- Silver plated rings are standard. Gold optional.
- 22, 16, 10 and 8 gauge lead wire
- Continuous 360° rotation of power or data signals
- Sealed unit
- Available as slip ring / brush block separates

### Benefits

- Transfers control and data signals
- Fiber brush technology provides maintenance-free operation (no lubrication required)
- Modular design meets special requirements through off-the-shelf manufacturing techniques
- May be customized for your application



### Typical Applications

- Industrial machinery – machining centers, rotary index tables, heavy equipment turrets or cable reels, test equipment, packaging and palletizing machines, magnetic clutches, process equipment, rotary sensors, emergency lighting, robotics
- Exhibit / display equipment
- Medical equipment



# Slip Rings With Through-Bores

Specifications		Options
Operating Speed	Up to 1000 rpm*	<ul style="list-style-type: none"> <li>• Longer lead lengths available</li> <li>• Power and signal combinations</li> <li>• Rotor and stator lead exits</li> <li>• Gold plated rings</li> </ul>
Number of Circuits	Various configurations	
Lead Lengths	12" (304mm) min from point of exit	
Voltage	600 VDC	
Max. Ambient Temp.	80°C	
Contact Material	Precious metal	
Current Rating	5, 10, 30 and 50 amps	
Lead Size	Signal circuits: #16 AWG, 10 amps Power circuits: #10 AWG, 30 amps #8 AWG, 50 amps #22 AWG, 5 amps	
Noise	100 milliohms, max.	
Dust / Splash Seals	Standard lip seal	
Leads	All white with tags	

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

Part #	# of Circuits	Capsule Length (L)	# of Modules
AC6275-6	6 power ckts max or 36 signal ckts max	6.6"	6
AC6275-12	12 power ckts max or 72 signal ckts max	11.2"	12
AC6275-18	18 power ckts max or 108 signal ckts max	15.7"	18
AC6275-24	24 power ckts max or 144 signal ckts max	20.5"	24

The AC6275 commercial slip ring provides configuration flexibility to meet your application needs. This product can be configured as required, with 5 amp signal, 10 amp rings, 30 amp rings and 50 amp rings.

Four set lengths are available, based on the number of modules that are required. These lengths are provided in the capsule length chart above.

Each module has 1-50 amp ring or 2-30 amp rings. For 10 amp rings, there are 1 to 3 rings per module. For 5 amp rings, there are 6 per module.

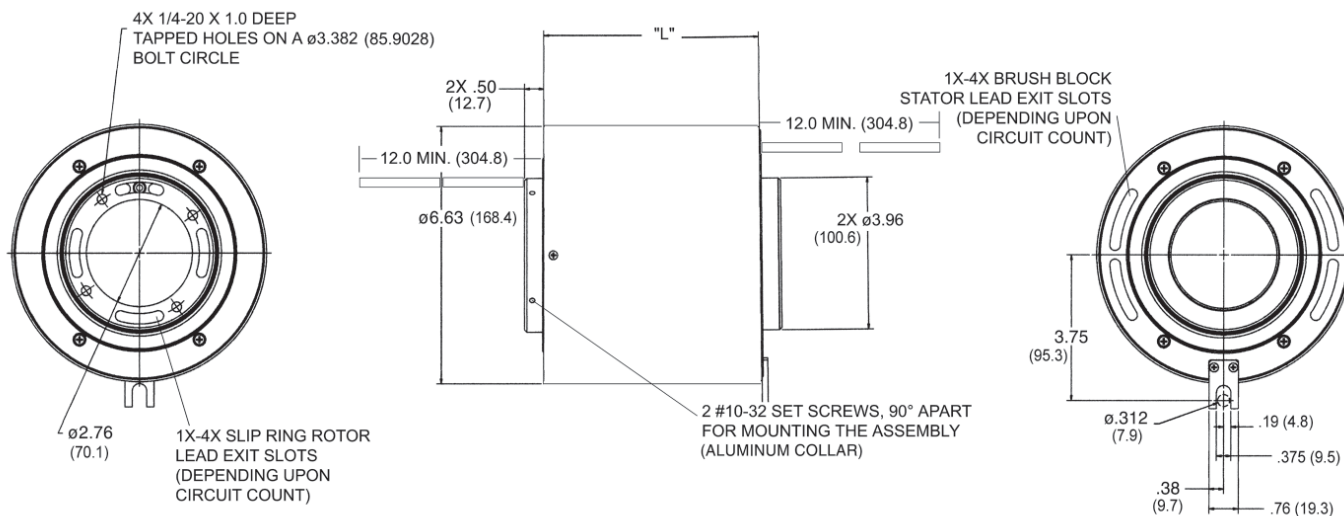
- 1) Define the number of signal / 10 amp rings, and round up to the closest multiple of 3 (i.e. 7 signal rings rounds up to 9 rings).
- 2) Divide this number by 3 to determine the number of signal / 10 amp modules.
- 3) Total the number of signal / 10 amp, 30 amp and 50 amp modules to define the total number of modules required.
- 4) If your total does not equal the 6, 12, 18 or 24 contained in the 4 lengths above, we will use spacers to fill out the unit to the nearest multiple of 6.

**Example:** 5 signal rings (2 X 3 = 6), 6 / 3 = 2 signal modules

(3 each) 30 amp rings = 3 modules

+5 modules

⇒ use 6 (closest multiple of 6)



Dimensions are in inches (millimeters)

# Slip Rings With Through-Bores

## AC6098

### 4 inch through-bore

#### Description

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and / or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, commutator, collector, swivel or a rotary joint.

The AC6098 is a commercial slip ring capsule that features a 4 inch through-bore and a compact 8 inch O.D. The through-bore provides routing space for hydraulics, pneumatics, or for a concentric shaft mount.

This slip ring is available in four lengths, from 4.6 to 14.4 inches (depending on the number of circuits required). It can be manufactured with 1 to 72 signal rings and 1 to 24 power rings. This "stacked module" approach allows us to quickly assemble the exact number and type of circuits that our customers require. Unlike most competitive units, the AC6098 transfers low level control and data signals. In addition, signal / data circuits can be combined with power circuits all in the same assembly. The slip ring can run up to 250 rpm continuous.

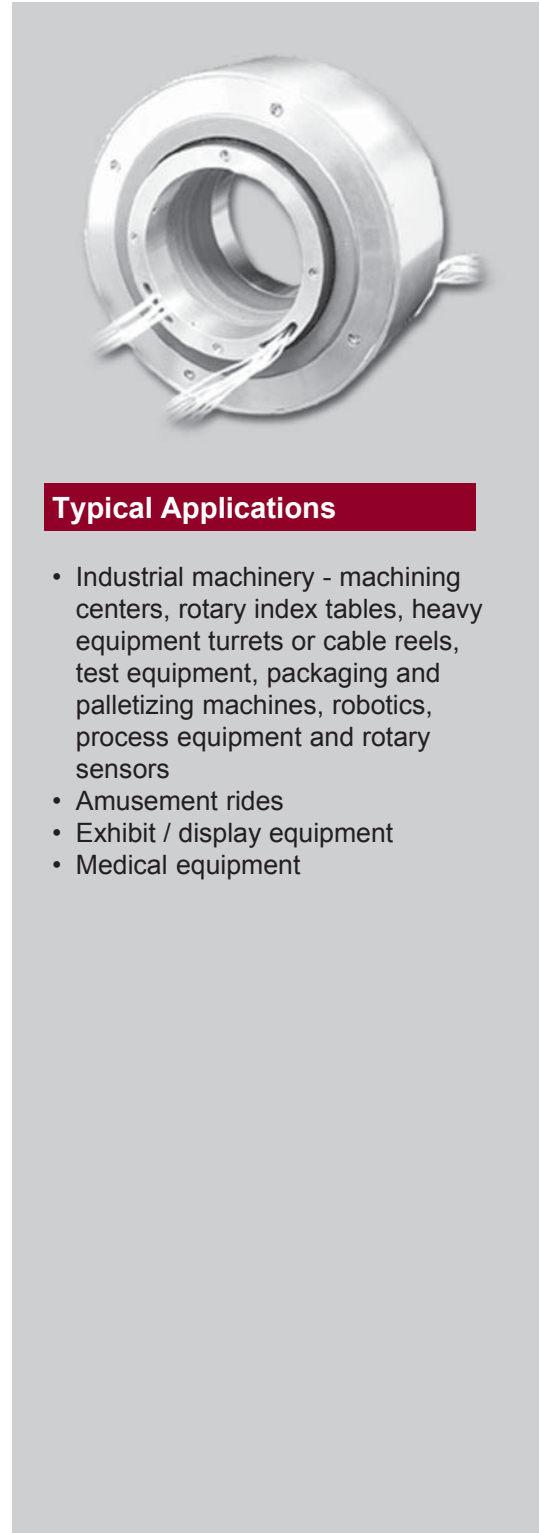
The AC6098 uses our fiber brush technology which offers several advantages over conventional slip ring contacts including multiple points of contact per brush bundle, low contact force per fiber and low contact wear rates. In addition, fiber brushes do not require lubrication and produce virtually no wear debris.

#### Features

- 4 inch through-bore
- 1 to 72 signal rings (signal up to 10 amps)
- 1 to 24 power rings (30 amp or 50 amp or some combination)
- Can combine signal and power in same slip ring
- Handles controller signals
- Speeds up to 250 rpm
- Silver plated rings; silver alloy fiber brushes
- Sealed against dust and splash

#### Benefits

- Compact design
- Design flexibility to meet your requirements
- Transfers low level control and data signals
- Provides the exact number of circuits required
- Fiber brush technology provides maintenance-free operation (no cleaning or lubrication required)



#### Typical Applications

- Industrial machinery - machining centers, rotary index tables, heavy equipment turrets or cable reels, test equipment, packaging and palletizing machines, robotics, process equipment and rotary sensors
- Amusement rides
- Exhibit / display equipment
- Medical equipment

# Slip Rings With Through-Bores

Specifications		Options
Operating Speed	250 rpm*	<ul style="list-style-type: none"> <li>• Longer lead lengths available</li> <li>• Power and signal combinations</li> </ul>
Number of Circuits	Various configurations	
Lead Lengths	12" (304mm) min from point of exit	
Voltage	600 VDC	
Max. Ambient Temp.	80°C	
Contact Material	Precious metal	
Current Rating	10, 30 and 50 amps	
Lead Size	Signal circuits: #16 AWG, 10 amps Power circuits: #10 AWG, 30 amps #8 AWG, 50 amps	
Noise	100 milliohms, max.	
Dust / Splash Seals	Standard lip seal	
Leads	All white with tags	

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

Part #	# of Circuits	Capsule Length (L)	# of Modules
AC6098-6	6 power ckts max or 18 signal ckts max	4.6" (111.8 millimeters)	1 to 6
AC6098-12	12 power ckts max or 36 signal ckts max	7.7" (195.6)	7 to 12
AC6098-18	18 power ckts max or 54 signal ckts max	11.1" (282.0)	13 to 18
AC6098-24	24 power ckts max or 72 signal ckts max	14.4" (365.8)	19 to 24

The AC6098 commercial slip ring provides configuration flexibility to meet your application needs. This product can be configured as required, with signal / 10 amp rings, 30 amp rings and 50 amp rings.

Four set lengths are available, based on the number of modules that are required. These lengths are provided in the capsule length chart above.

Each 30 amp and 50 amp ring is one module. For signal / 10 amp rings, there are 1 to 3 rings per module. To determine the length of your capsule:

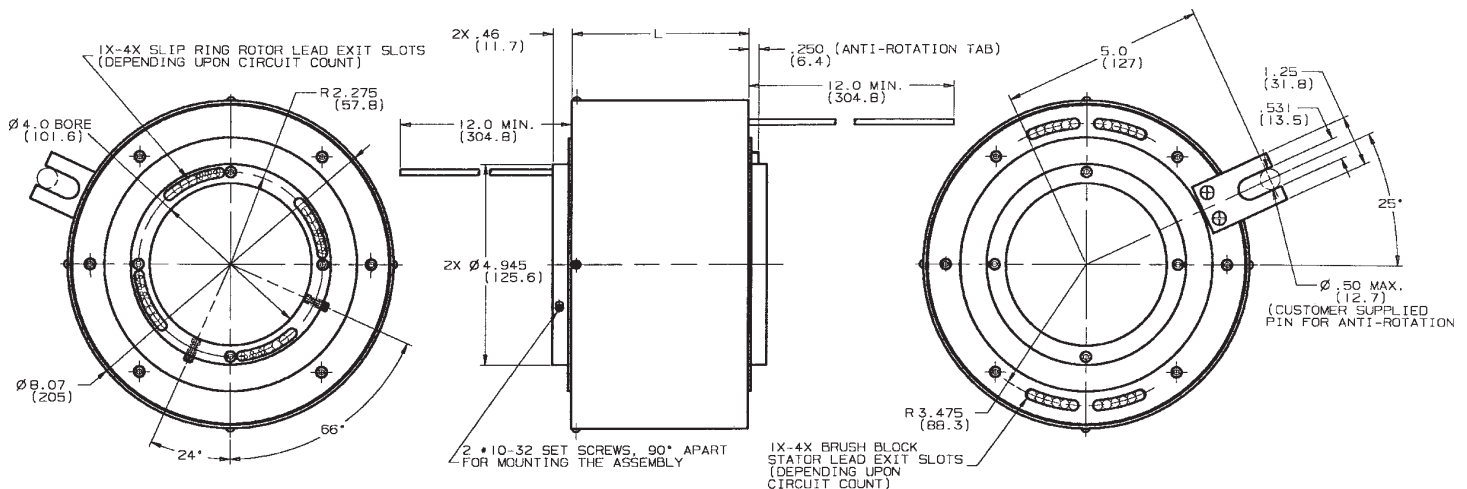
- 1) Define the number of signal / 10 amp rings, and round up to the closest multiple of 3 (i.e. 7 signal rings rounds up to 9 rings).
- 2) Divide this number by 3 to determine the number of signal / 10 amp modules.
- 3) Total the number of signal / 10 amp, 30 amp and 50 amp modules to define the total number of modules required.
- 4) If your total does not equal the 6, 12 18 or 24 contained in the 4 lengths above, we will use spacers to fill out the unit to the nearest multiple of 6.

**Example:** 5 signal rings (2 X 3 = 6), 6 / 3 = 2 signal modules

(3 each) 30 amp rings = 3 modules

+5 modules

⇒ use 6 (closest multiple of 6)



Dimensions are in inches (millimeters)

# Slip Ring Capsules (Compact)

## AC6373

### *Compact slip ring capsule*

#### **Description**

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and/or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, commutator, collector, swivel or an electrical rotary joint.

The AC6373 miniature capsule provides up to 12, 2 amp rated contacts in a small, 1/2" diameter design. Color-coded lead wires are provided on both the rotor and stator to allow simplified electrical connections. Similar in design to our very popular AC6023 family, the AC6373 allows tremendous flexibility in dealing with system size restrictions. It is available in 6 and 12 circuit configurations.

#### **Features**

- 6 and 12 circuit models
- 2 amp, 120 VDC / VAC circuits
- Precision assembly to provide exceptional rotational life
- Speeds up to 100 rpm continuous
- Compact size 1/2" diameter, .58" or .83" long
- Gold-on-gold contacts
- Mounting flange on housing
- Flexible, color-coded, silver-plated lead wire
- Superior handling of low level control signals

#### **Benefits**

- Extremely compact
- Low torque
- Quick shipment
- High bandwidth transfer capability



#### **Typical Applications**

- CCTV pan / tilt camera mounts
- Medical equipment
- Robot end effectors
- Miniature cable reels
- Laboratory equipment

# Slip Ring Capsules (Compact)

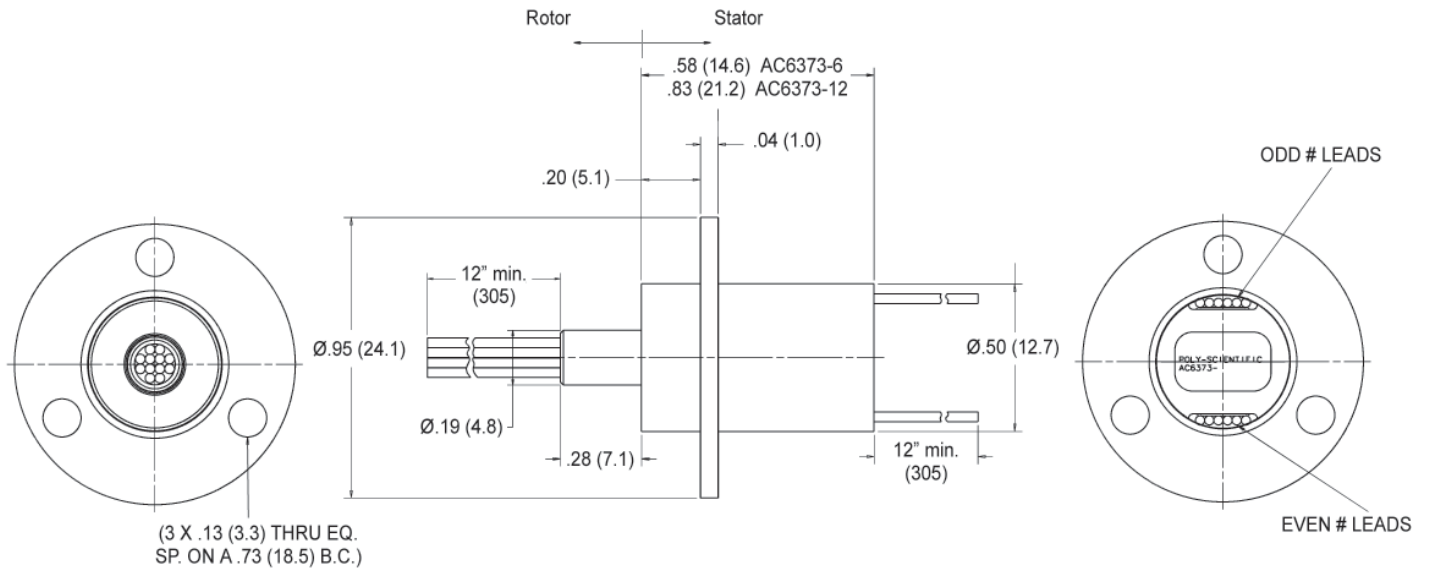
Specifications	
Operating Speed	100 rpm*
Number of Circuits	6 or 12
Lead Lengths	12 inches
Voltage	120 VDC ; 120 VAC
Max. Ambient Temp.	80°C
Contact Material	Gold
Current Rating	2 amps / circuit
Lead Size / Type	26 (7 / 34) silver plated copper Type ET Teflon® insulated
Dielectric Strength	500 VAC @ 60 Hz, between each circuit and all other circuits
Insulation Resistance	1000 megohms @ 500 VDC
Circuit Resistance	100 milliohms with 12 inch leads
Noise	60 milliohms max tested @ 6 VDC, 50 milliamps when running @ 5 - 15 rpm

AC6373 Lead Wire Color Codes			
Ring#	Color Code	Ring#	Color Code
#1	BLK	#7	BLU
#2	BRN	#8	VIO
#3	RED	#9	GRY
#4	ORN	#10	WHT
#5	YEL	#11	WHT-BLK
#6	GRN	#12	WHT-BRN

Part Number	Length
AC6373 - 6	.58" (14.6)
AC6373 - 12	.83" (21.2)

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

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Dimensions in inches (millimeters)

# Slip Ring Capsules (Compact)

## AC6023

### *Compact in various circuit configurations*

#### **Description**

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and / or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, commutator, collector, swivel or an electrical rotary joint.

The AC6023 slip ring capsule is a standard, off-the-shelf unit that uses gold contacts at the rotary interface. Color-coded lead wires are used on both the stator and rotor for simplified electrical connections. Similar in design to our popular AC4898 capsule, the AC6023 is 25 - 38 percent shorter in length (depending on the model chosen), providing increased flexibility when dealing with size restrictions.

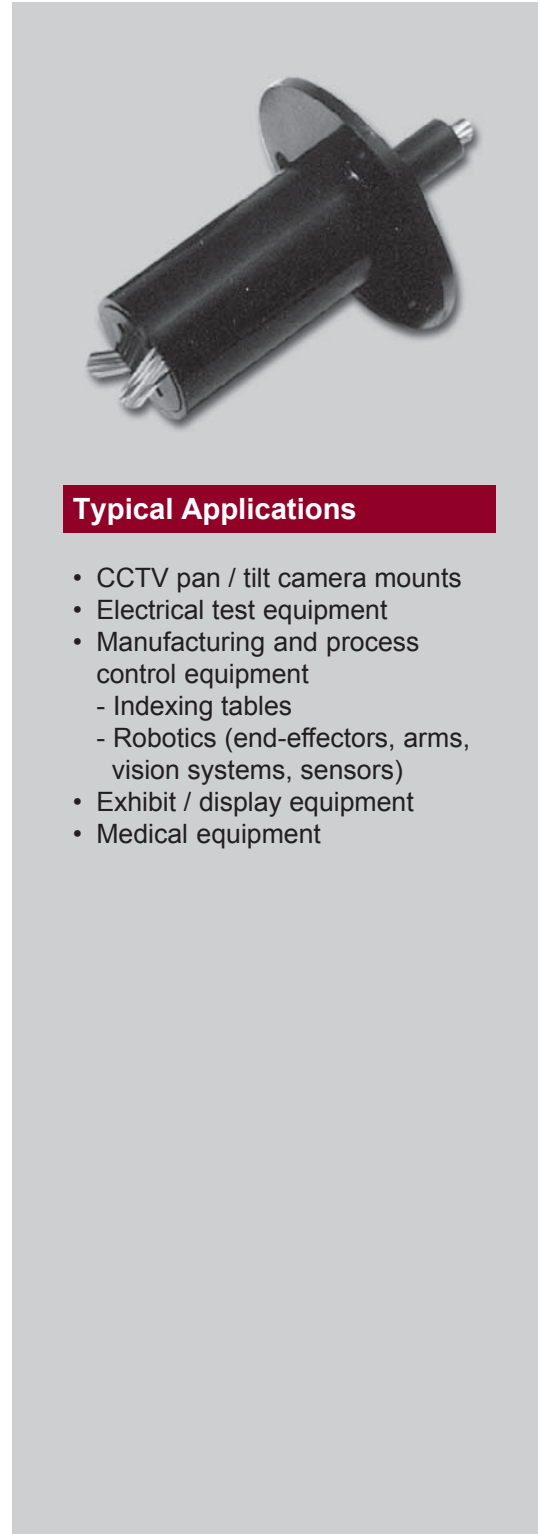
Using a 90° V-groove ring design for each ring, the AC6023 provides smoother running, lower torque and lower (electrical) noise than competitive slip rings. It is available in 6, 12, 18 and 24 circuit models.

#### **Features**

- 6, 12, 18 and 24 circuit models
- 2 amp / 210 VDC / 240 VAC circuits
- Precision ball bearings meet or exceed life requirements for most commercial applications
- Speeds up to 250 rpm continuous
- Compact size: 0.57 inch to 1.38 inch lengths (depending upon number of circuits)
- Gold-on-gold contacts
- 12 inch, 24 inch, 36 inch, 48 inch standard lead lengths
- Compatible with data bus protocols
- Sealed units are also available
- Flexible, color-coded, silver-plated, Teflon® insulated lead wires
- Transfers analog and digital signals
- Also available with 5 and 10 amp power rings combined with 2 amp rings. Please refer to AC6305 / AC6310 data sheet.

#### **Benefits**

- Smooth running
- Low torque
- Compact
- Quick shipment



#### **Typical Applications**

- CCTV pan / tilt camera mounts
- Electrical test equipment
- Manufacturing and process control equipment
  - Indexing tables
  - Robotics (end-effectors, arms, vision systems, sensors)
- Exhibit / display equipment
- Medical equipment

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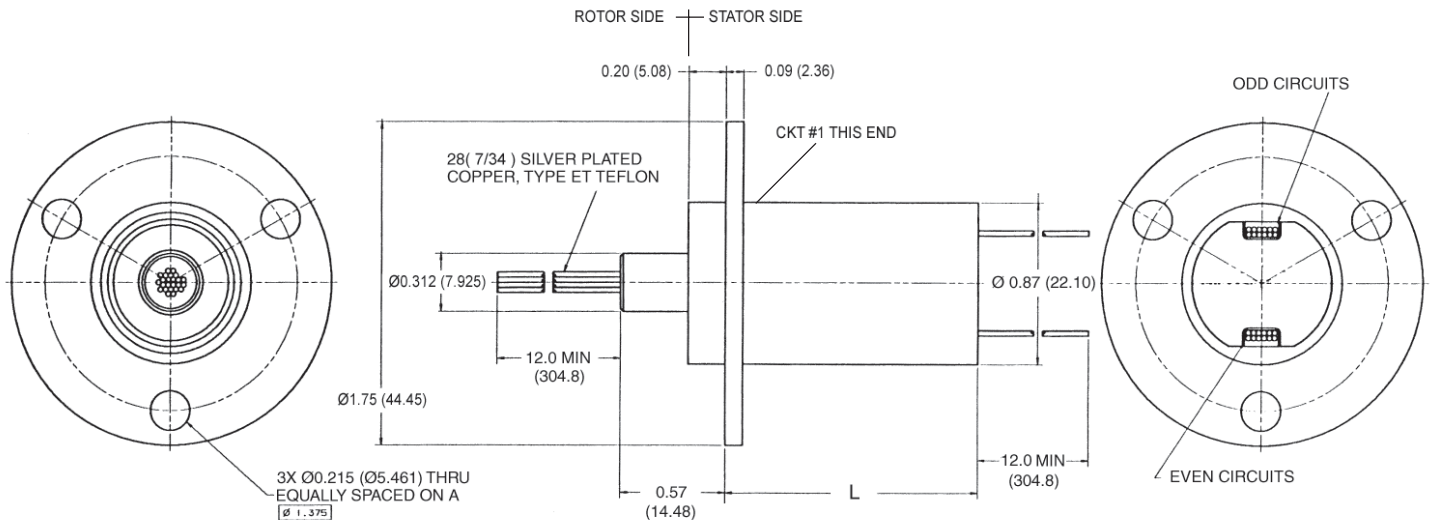
# Slip Ring Capsules (Compact)

Specifications	
Operating Speed	250 rpm*
Number of Circuits	6, 12, 18, or 24
Lead Lengths	12, 24, 36, and 48 inches
Voltage	210 VDC / 240 VAC
Temperature Range	-40°C to +80°C
Contact Material	Gold
Current Rating	2 amps / ckt
Lead Size / Type	28 (7/34) Silver plated copper, Type ET Teflon®
Dielectric Strength	500 VAC @ 60 Hz, between each circuit and all other circuits
Insulation Resistance	1000 megohms @ 500 VDC
Noise	100 milliohms max tested @ 6 VDC, 50 milliamps when running @ 5 rpm

Lead Wire Color Codes					
Ring#	Color Code	Ring#	Color Code	Ring#	Color Code
#1	BLK	#9	GRY	#17	WHT-BLU
#2	BRN	#10	WHT	#18	WHT-VIO
#3	RED	#11	WHT-BLK	#19	WHT-GRY
#4	ORN	#12	WHT-BRN	#20	WHT-BLK-BRN
#5	YEL	#13	WHT-RED	#21	WHT-BLK-RED
#6	GRN	#14	WHT-ORN	#22	WHT-BLK-ORN
#7	BLU	#15	WHT-YEL	#23	WHT-BLK-YEL
#8	VIO	#16	WHT-GRN	#24	WHT-BLK-GRN

Capsule Length = L		
# of circuits	Capsule length (L)	Part #
6	0.57" (14.5 millimeters)	AC6023-6
12	0.84" (21.3)	AC6023-12
18	1.11" (28.2)	AC6023-18
24	1.38" (35.1)	AC6023-24

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.



Dimensions are in inches (millimeters)

# Slip Ring Capsules (Compact)

## AC6355

*Compact in various circuit configurations*

### Description

A slip ring capsule can be used in any electromechanical system that requires unrestrained, intermittent, or continuous rotation while transferring power and / or data.

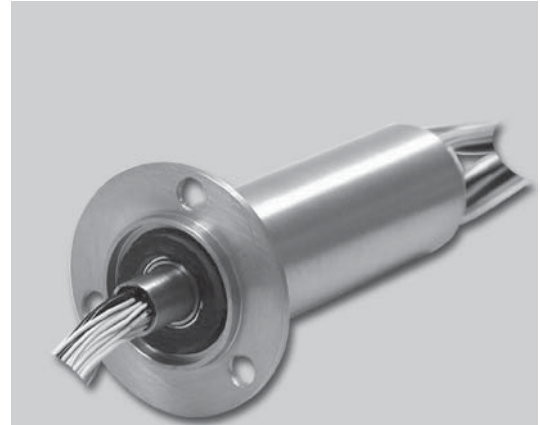
The AC6355 provides an economical, readily available solution when a compact, high circuit count configuration is required. Our standard units, AC6355-36 and AC6355-56 offer 36, 2 amp and 56, 2 amp signal rings respectively. These units can be modified to provide various combinations of power, signal and coax connections. Similar in design to our very popular AC6023, this design features gold-on-gold contact technology for ultimate performance in many challenging applications.

### Features

- Standard 36 and 56 circuit models with 2 amp circuits
- 2 amp, 5 amp, 10 amp combinations standard; 50 or 75 ohm coax circuits optional
- Precision ball bearing for long life
- Speeds up to 250 rpm continuous
- Compact size
- Sealed units available
- Metal housing available
- Transfer analog and digital signals
- Compatible with data bus protocols

### Benefits

- Unique signal handling performance with minimal electrical circuit noise
- Tight packaging to fit in the most demanding space constraints
- Low torque to minimize system torque budget
- Rapid delivery



### Typical Applications

- Pan / tilt camera mounts
- Rotary index tables
- Rate tables
- Lighting
- Robotics



# Slip Ring Capsules (Compact)

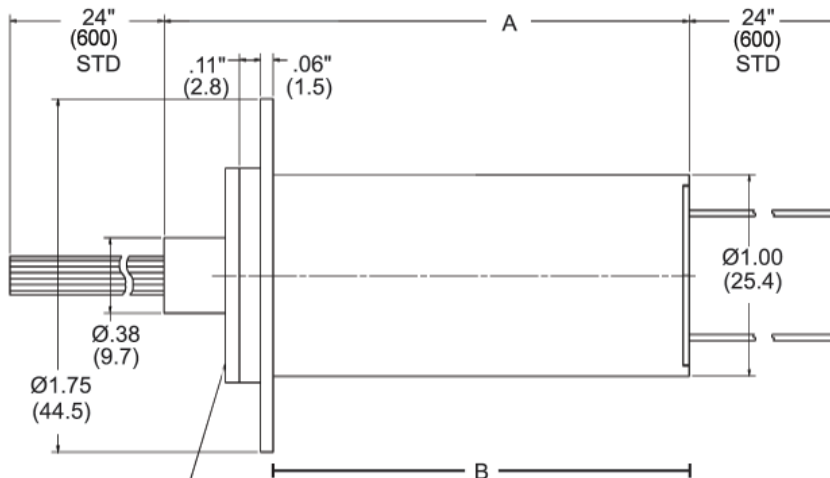
Specifications		Options
Operating Speed	250 rpm	
Circuit Configurations	36 ring	56 ring
	36 @ 2 amp	56 @ 2 amp
	4 @ 5 amp; 28 @ 2 amp	4 @ 5 amp; 48 @ 2 amp
	4 @ 10 amp; 20 @ 2 amp	4 @ 10 amp; 40 @ 2 amp
Lead Length	24 inch (600 mm)	
Voltage	210 VDC	
Operating Temp.	-40°C to +80°C	
Contact Material	Gold-on-gold signal; gold-on-gold power	
Housing	Plastic	
Lead Size / Type	2 amp, 26 AWG 5 amp, 20 AWG 10 amp, 16 AWG	
Dielectric Strength	250 VAC @ 60 Hz, between each circuit and all other circuits	
Insulation Resistance	1000 megohms max tested @ 500 VDC	
Electrical Noise	60 milliohms max when tested @ 6VDC 50 milliamps when running @ 10 rpm	
		<ul style="list-style-type: none"> <li>• 50 or 75 ohm coax combined with 2 and 5 amp rings</li> <li>• 48 inch (1200 mm)</li> <li>• Silver-on-gold power</li> <li>• Aluminum</li> <li>• 50 ohm coax, RG178</li> <li>• 75 ohm coax, RG179</li> </ul>

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

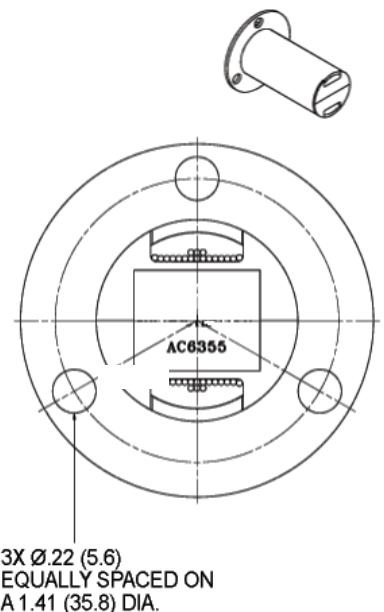
Ring #	Color	Ring #	Color	Ring #	Color	Ring #	Color
1	BLK	19	BLK	37	BLK	55	BLK
2	BRN	20	BRN	38	BRN	56	BRN
3	RED	21	RED	39	RED		
4	ORN	22	ORN	40	ORN		
5	YEL	23	YEL	41	YEL		
6	GRN	24	GRN	42	GRN		
7	BLU	25	BLU	43	BLU		
8	VIO	26	VIO	44	VIO		
9	GRY	27	GRY	45	GRY		
10	WHT	28	WHT	46	WHT		
11	WHT-BLK	29	WHT-BLK	47	WHT-BLK		
12	WHT-BRN	30	WHT-BRN	48	WHT-BRN		
13	WHT-RED	31	WHT-RED	49	WHT-RED		
14	WHT-ORN	32	WHT-ORN	50	WHT-ORN		
15	WHT-YEL	33	WHT-YEL	51	WHT-YEL		
16	WHT-GRN	34	WHT-GRN	52	WHT-GRN		
17	WHT-BLU	35	WHT-BLU	53	WHT-BLU		
18	WHT-VIO	36	WHT-VIO	54	WHT-VIO		

2 amp leads will be color coded  
5 amp rings will have 20 AWG black lead wire, tagged  
10 amp rings will have 16 AWG black lead wire, tagged

AC6355	A	B
56 Ring	3.50 (88.9)	2.96 (75.3)
36 Ring	2.60 (66.04)	2.06 (52.4)



LIP SEAL OPTIONAL FOR SEALING UNIT.



Dimensions in inches (mm)

# Slip Ring Capsules (Compact)

## AC6379

### *Fiber Optic Rotary Joint and Slip Ring In various circuit configurations*

#### **Description**

The AC6379 is a unique rotary component that can combine both a single channel Fiber Optic Rotary Joint (FORJ) and an electrical slip ring in the same mechanical assembly. This unique assembly has a single multimode fiber optic channel and can also have 24 electrical circuits rated at 2 amperes each.

The FORJ features the same expanded beam optical system that is used in our field proven FO3585 design. This system minimizes insertion loss and rotational variation in the optical system.

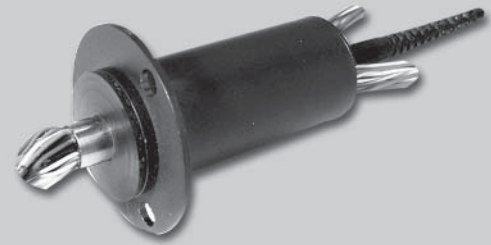
The slip ring section of the assembly is based on technology used in the AC6355 unit. The assembly features precision ball bearing for long life and is rated for continuous operation at speeds up to 250 rpm. The electrical section uses a gold-on-gold contact technology, which provides the ultimate in performance for demanding applications.

#### **Features**

- Standard 24 circuit model with 2 amp circuits
- Precision ball bearing for long life
- Speeds up to 250 rpm continuous
- Compact size
- Sealed units available
- Metal housing available
- Transfer analog and digital signals
- Compatible with data bus protocols
- Single fiber optical rotary joint

#### **Benefits**

- Unique signal handling performance with minimal electrical circuit noise
- Tight packaging to fit in the most demanding space constraints
- Low torque to minimize system torque budget
- Rapid delivery



#### **Typical Applications**

- Pan / tilt camera mounts
- Rotary index tables
- Rate tables
- Lighting
- Robotics

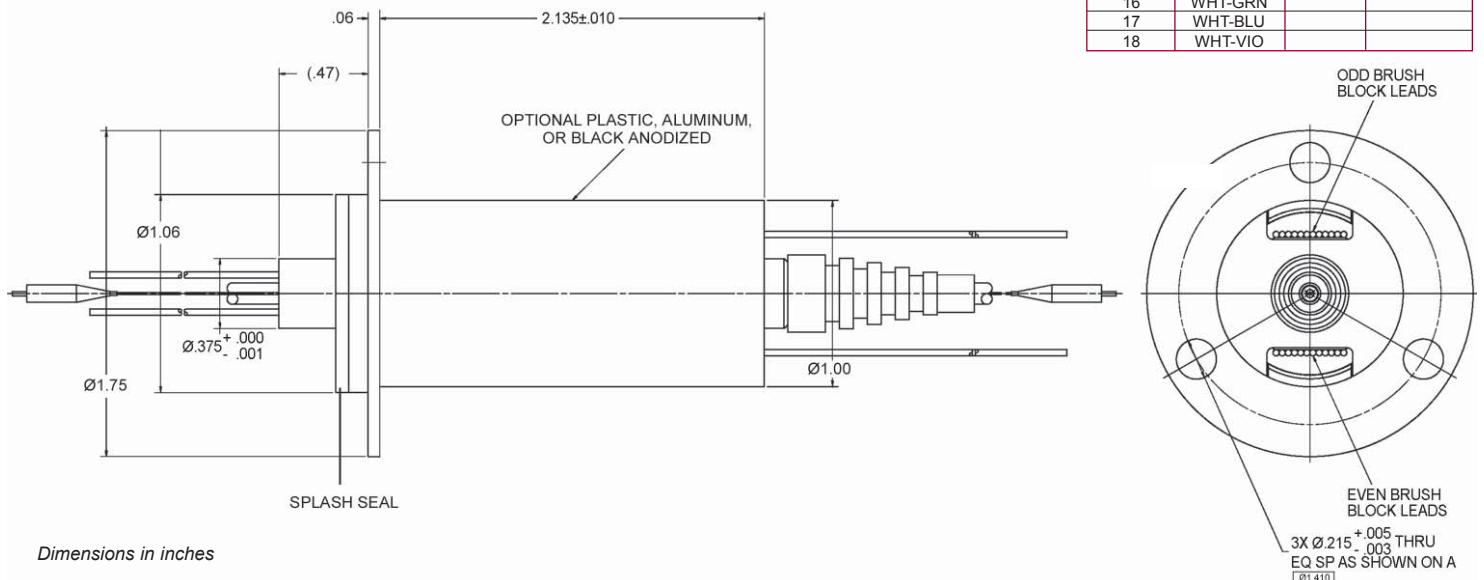
# Slip Ring Capsules (Compact)

Specifications		Options
Operating Speed	250 rpm max. connectors	
Circuit Configurations	24 @ 2 amp	
Lead Length	24 inch (600 mm) optical and electrical +100/0 mm	• 48 inch (1200 mm)
Voltage	210 VDC	
Operating Temp.	-40°C to +80°C	
Contact Material	Gold-on-gold signal; silver	• Gold
Housing	Plastic	• Aluminum, black anodized
Lead Size / Type	Elec. 2 amp, 26 AWG Optical 62.5 / 125 nm multimode with 2 mm jackets	
Dielectric Strength	250 VAC @ 60 Hz, between each circuit and all other circuits	
Insulation Resistance	1000 megohms max tested @ 500 VDC	
Electrical Noise	60 milliohms max when tested @ 6VDC 50 milliamps when running @ 10 rpm	
Optical Insertion Loss	3.5 dB max. at 850 nm and 1300 nm	
Return Loss	-20 dB min.	
Optical Connectors	ST	• FC

\*Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

2 amp leads will be color coded

Ring #	Color	Ring #	Color
1	BLK	19	BLK
2	BRN	20	BRN
3	RED	21	RED
4	ORN	22	ORN
5	YEL	23	YEL
6	GRN	24	GRN
7	BLU		
8	VIO		
9	GRY		
10	WHT		
11	WHT-BLK		
12	WHT-BRN		
13	WHT-RED		
14	WHT-ORN		
15	WHT-YEL		
16	WHT-GRN		
17	WHT-BLU		
18	WHT-VIO		



Dimensions in inches

# Slip Ring Capsules (Compact)

## AC6305

## AC6310

*Compact in various circuit configurations*

### Description

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and / or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, commutator, collector, swivel or an electrical rotary joint.

The AC6305 provides 3 circuits at 5 amps along with 6, 9, or 12 signal (2 amp max) circuits. The AC6310 provides 3 circuits at 10 amps and 3 or 6 signal circuits. This compact power and signal handling design provides unique capability for many challenging applications.

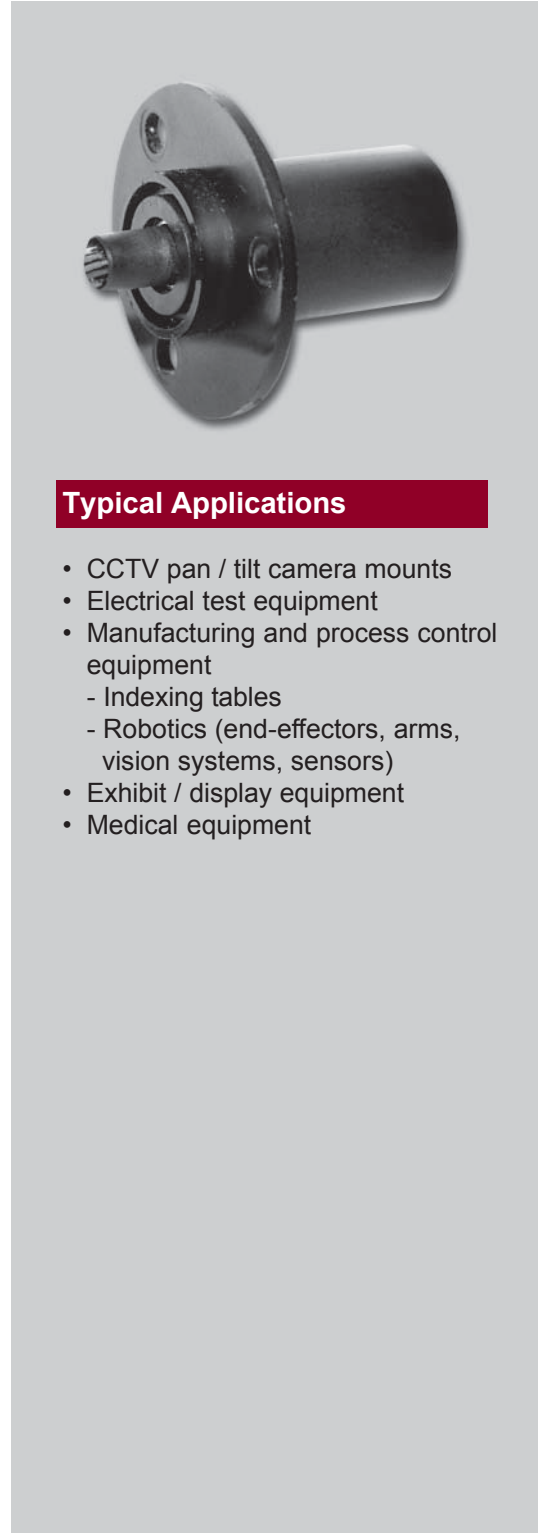
### Features

- 6, 9, 12 and 15 circuit models
- 5 amp / 2 amp and 10 amp / 2 amp circuit combinations
- Precision ball bearings meet or exceed life requirements for most commercial applications
- Speeds up to 250 rpm continuous
- Compact size: 1.38" long
- Gold-on-gold contacts
- 12", 24", 36", 48" standard lead lengths (longer lead lengths are available)
- Sealed units are also available (dust and light splash only)
- Flexible silver-plated copper, color-coded, Teflon® insulated lead wires
- Fully compatible with both analog and TTL control level signals
- Also available with 6, 12, 18, and 24, 2 amp rings. Please refer to AC6023 data sheet.

### Benefits

- Smooth running
- Low torque
- Compact
- Very low noise (electrical)
- Quick shipment

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### Typical Applications

- CCTV pan / tilt camera mounts
- Electrical test equipment
- Manufacturing and process control equipment
  - Indexing tables
  - Robotics (end-effectors, arms, vision systems, sensors)
- Exhibit / display equipment
- Medical equipment

# Slip Ring Capsules (Compact)

Specifications		
	AC6305	AC6310
Operating Speed	250 rpm*	250 rpm*
Number of Circuits	3 @ 5 amps and 6, 9, or 12 @ 2 amps	3 @ 10 amps and 3 or 6 @ 2 amps
Lead Lengths	12, 24, 36 and 48 inches	12, 24, 36 and 48 inches
Voltage	120 VAC	120 VAC
Max Ambient Temp.	80°C	80°C
Contact Material	Gold	Gold
Current Rating	5 amp and 2 amps / ckt	10 amp and 2 amps / ckt
Lead Size / Type	2 amp, 26 gauge silver plated copper 5 amp, 20 gauge silver plated copper	2 amp, 26 gauge silver plated copper, 10 amp, 16 gauge silver plated copper
Dielectric Strength	250 VAC @ 60 Hz, between each circuit and all other circuits	250 VAC @ 60 Hz, between each circuit and all other circuits
Insulation Resistance	1000 megohms @ 500 VDC	1000 megohms @ 500 VDC
Circuit Resistance	200 milliohms with 12" leads	200 milliohms with 12" leads
Noise	60 milliohms max tested @ 6 VDC, 50 milliamps when running @ 5 rpm	60 milliohms max tested @ 6 VDC 50 milliamps when running @ 5 rpm

\* Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.

## AC6305 Lead Wire Color Codes

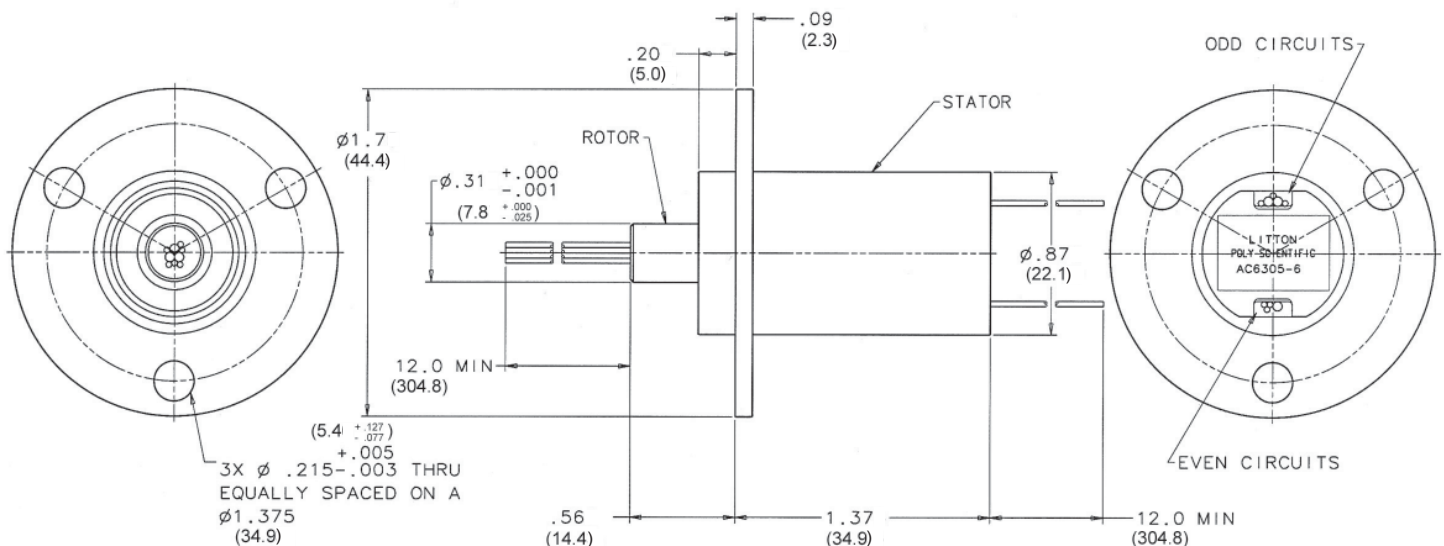
Ring #	Color Code	Ring #	Color Code
#1	BLK	#9	GRN
#2	BLK	#10	BLU
#3	BLK	#11	VIO
#4	BLK	#12	GRY
#5	BRN	#13	WHT
#6	RED	#14	WHT-BLK
#7	ORN	#15	WHT-BRN
#8	YEL		

20 AWG  
TAGGED  
LEADS

## AC6310 Lead Wire Color Codes

Ring#	Color Code	Ring#	Color
#1	BLK	Code	
#2	BLK	#6	RED
#3	BLK	#7	ORN
#4	BLK	#8	YEL
#5	BRN	#9	GRN

16 AWG  
TAGGED  
LEADS



Dimensions are in inches (millimeters)

# High Speed Slip Ring Capsules

## EC3848

### *High Speed*

#### **Description**

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transmitting power and/or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, collector, swivel or rotary joint. A slip ring can improve system performance by simplifying operations and eliminating damage-prone wires dangling from moving joints.

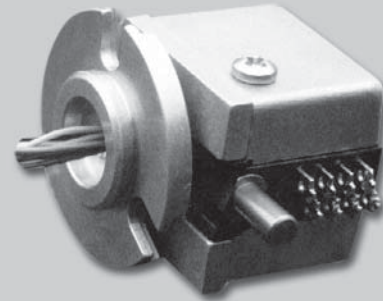
The EC3848 features precious metal contacts at the rotary interface. Flying lead wires on the rotating side and solder terminals on the stator side complete the electrical connections. Precision ball bearings and the patented fiber brush design allow operation up to 10,000 rpm without the need for cooling equipment. Fiber brush technology offers several advantages over conventional slip ring contacts including multiple points of contact per brush bundle, low contact force per fiber and low contact wear rates. In addition, fiber brushes do not require lubrication and produce virtually no wear debris.

#### **Features**

- Speeds up to 10,000 rpm without cooling
- 2, 6, 8 and 10 circuit models
- Precision ball bearings
- 1 amp / 100 VDC circuits
- Precious metal contacts

#### **Benefits**

- Transfers control and data signals
- Fiber brush technology provides maintenance-free operation (no lubrication required)
- Standard design meets high speed requirements at a fraction of the cost of a custom assembly



#### **Typical Applications**

- Centrifuges
- Various high speed instrumentation applications such as tire testing

# High Speed Slip Ring Capsules

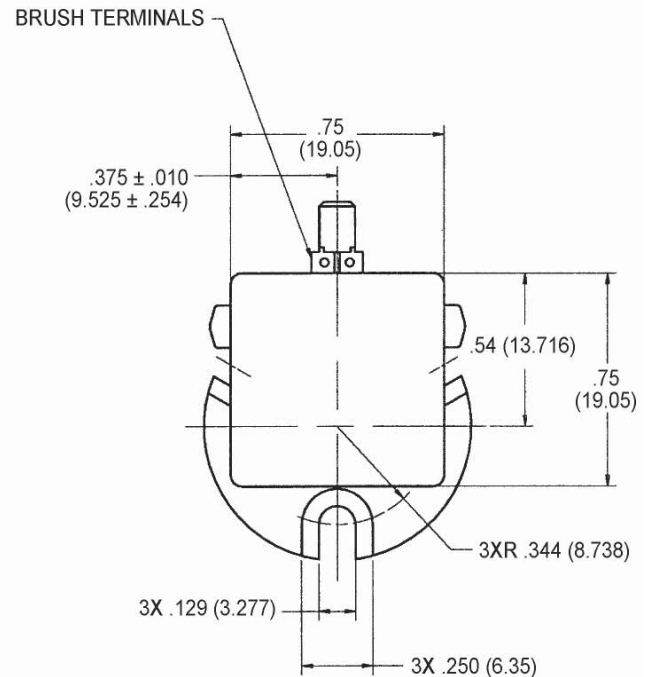
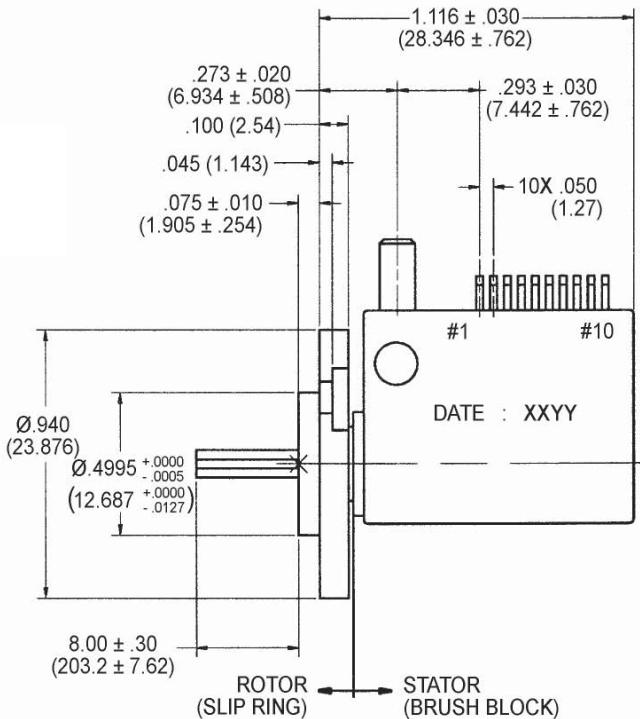
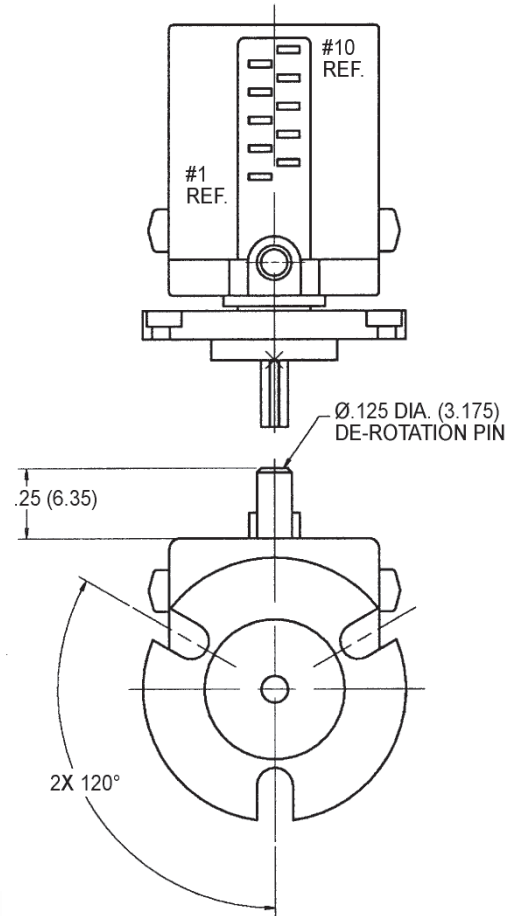
## Specifications

Operating Speed	0 - 10,000 rpm*
Cooling	Not required
Number of Rings	Up to 10
Electrical Noise	20 mΩ at 5 rpm 6 VDC, 50 mA current
Insulation Resistance	1000 MΩ at 500 VDC
Current	1.0 amps maximum per ring
Voltage	Low millivolt range to 100 VDC
Maximum Ambient Temperature	50°C (120°F) over 1,000 rpm 80°C (175°F) up to 1,000 rpm
Contact Material	Precious metal
Electrical Connections	30 (19 / 42) AWG leads on rotor. Solder terminals on stator.

## Lead Wire Color Code

Ring#	Color Code	Ring#	Color Code
#1	BLK	#6	GRN
#2	BRN	#7	BLU
#3	RED	#8	VIO
#4	ORN	#9	GRY
#5	YEL	#10	WHT

\* Please note that the operational life of the unit is dependent upon rotational speed, environment and temperature.



Dimensions are in inches (millimeters)

# High Speed Slip Ring Capsules

## AC3757

### Miniature Slip Ring Assembly

#### Description

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and / or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, commutator, collector, swivel or a rotary joint.

The AC3757 high speed slip ring provides 36 circuits and operational speeds up to 6,000 rpm. Our fiber brush technology minimizes contact wear and resultant debris while it extends operational life.

#### Features

- 36 circuits
- High speed performance with customer's cooling systems:
  - 4,000 rpm without cooling
  - 6,000 rpm with gas cooling (nitrogen)
- Thermocoupled leads are available
- Low noise. The low contact force of the fiber brush design reduces resistance (noise) while providing superior power and data transfer capability.
- Cooling tubes

#### Benefits

- Fiber brush technology. The sliding electrical contacts used in the AC3757 slip ring features our fiber brush technology to provide these benefits:
  - Low contact force per fiber
  - Low contact wear rates
  - Contact surfaces that do not require lubrication
  - Ability to perform in vacuum and varied ambient conditions
- Improved system performance. Slip rings can improve mechanical performance, simplify system operation and eliminate damage-prone wires dangling from movable joints.



#### Typical Applications

This slip ring provides high speed performance and is successfully serving in applications such as:

- Centrifuges
- Tire testing
- Gasoline or diesel engine testing
- Aircraft turbine testing
- Rocket testing



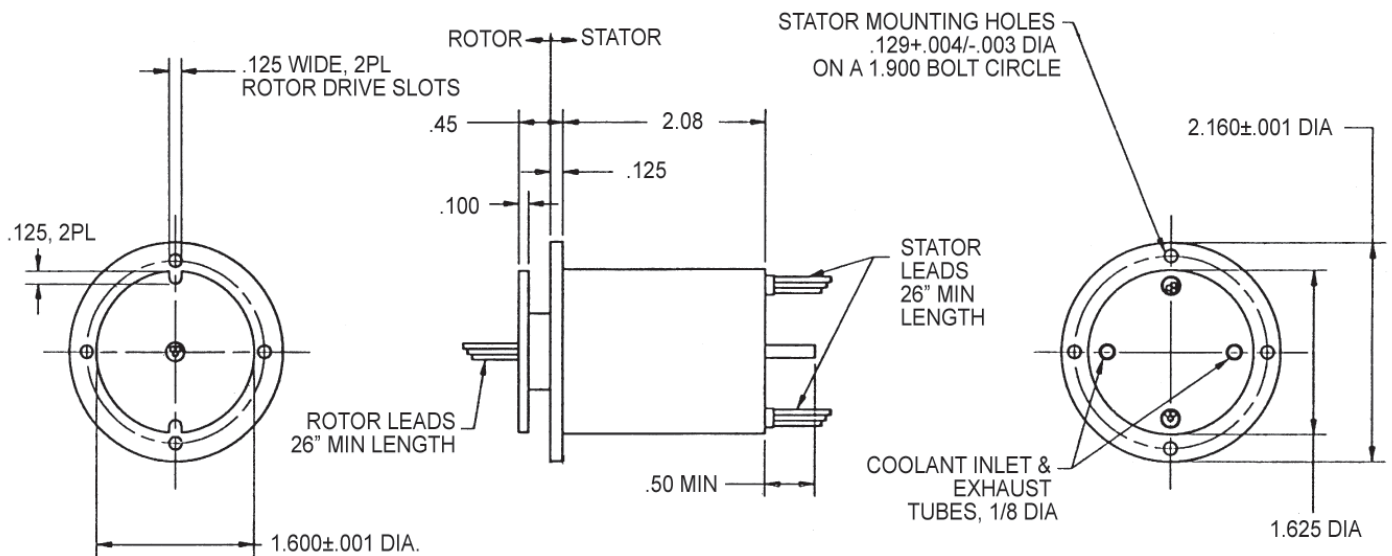
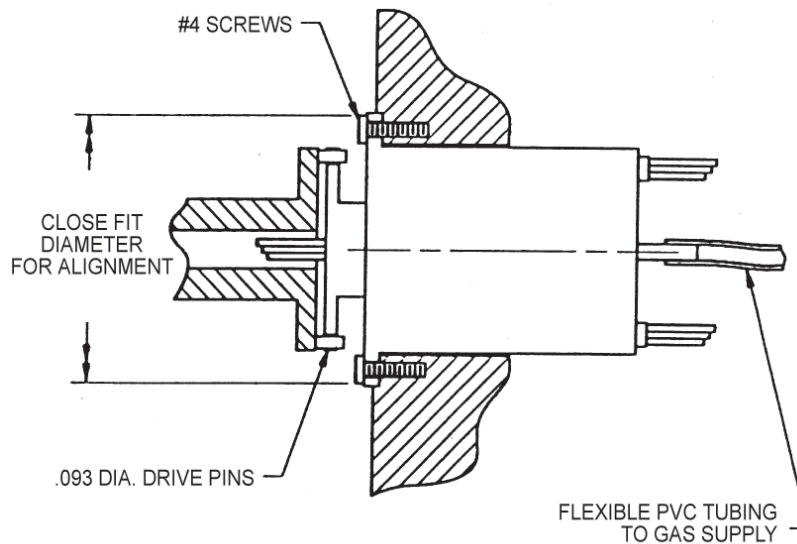
# High Speed Slip Ring Capsules

Specifications	
Ring O.D.	0.270
Ring Pitch	0.032
Flange Diameter	1.600
Bore	None
Volts (Peak to Peak)	70
<b>Circuits</b>	<b>Leads</b>
1-26	30 (19 / 42) AWG silver plated standard copper conductor
27-36	Solid chromel & alumel leads
All leads are color coded extruded teflon insulation.	
Chromel / alumel thermocouple pairs are attached to each bearing and to brushes #1 and #12 to monitor temperature.	

Lead Wire Color Codes							
Ring #	Color Code	Ring #	Color Code	Ring #	Color Code	Ring #	Color Code
#1	BLK	#10	WHT	#19	WHT-GRY	#28	ORN (ALUMEL)
#2	BRN	#11	WHT-BLK	#20	WHT-BLK-BRN	#29	BLK (CHROMEL)
#3	RED	#12	WHT-BRN	#21	WHT-BLK-RED	#30	BRN (ALUMEL)
#4	ORN	#13	WHT-RED	#22	WHT-BLK-ORN	#31	RED (CHROMEL)
#5	YEL	#14	WHT-ORN	#23	WHT-BLK-YEL	#32	ORN (ALUMEL)
#6	GRN	#15	WHT-YEL	#24	WHT-BLK-GRN	#33	BLK (CHROMEL)
#7	BLU	#16	WHT-GRN	#25	WHT-BLK-BLU	#34	BRN (ALUMEL)
#8	VIO	#17	WHT-BLU	#26	WHT-BLK-VIO	#35	RED (CHROMEL)
#9	GRY	#18	WHT-VIO	#27	RED (CHROMEL)	#36	ORN (ALUMEL)

**Note:** Other combinations of standard conductors and thermocouple leads are available.

## Recommended Mounting Arrangement



Dimensions are in inches

# Large Diameter Slip Rings

## Large Slip Ring Assemblies

### Description

Large bore slip rings represent the union of manufacturing processes and technologies that enable us to offer large, high volume slip rings with advanced features that are cost effective. The manufacturing processes allow the slip ring to be built in an assembly-line fashion, significantly reducing delivery time and price.

The design features traditional sliding contact technology for the transfer of power and control signals utilizing fiber brush technology. The fiber brush technology's low contact force provides extremely long life while producing minimal wear debris, compared to composite-type graphite brushes. Lower brush forces also make the system quieter.

Large slip rings also feature optical channels for high-speed data communications, up to 1.32 Gb/s per optical signal. This patented technology also has the capability to transfer multiple optical signals per optical channel, resulting in data rate capacities in excess of five gigabits per channel. The technology is also scalable to accommodate various data handling requirements and is capable of communicating in both directions across a rotary interface. These last two features greatly increase design flexibility and capability.

### Features

- Long maintenance-free life. The fiber brush block with its very low contact force provides for long life with minimal debris, unlike the composite-type graphite brushes often used in high surface speed applications. Our fiber brush technology provides many benefits including low contact wear rates and increased power and signal transfer capabilities.
- Quieter mechanical system operation.
- High data rates. High frequency design provides excellent digital data transfer. The electrical fiber brush design is usable to 50 Mb/s and the optical design is capable of 1.32 Gb/s per optical signal with the capability for multiple signals. The optical technology is capable of transferring data in both directions across a rotary interface.
- Large sizes. We offer slip rings with an inside diameter up to 50" and length up to 18". Rotation speeds depend upon the diameter of the unit. The number of circuits is length and power dependent.
- Quieter Mechanical System Operation. A fiber brush design produces virtually no audible noise, which reduces machine noise and patient stress.
- Chances are, if you are using a slip ring in your system, you'll also require a motor to produce rotary motion. We offer a full line of fractional horsepower DC motors including brush, brushless, and torque designs.



### Typical Applications

- Medical CT scanners
- Luggage scanners
- Amusement rides
- Cranes
- Offshore mooring

# Large Diameter Slip Rings

Specifications*	
Size Range	ID to 50"; Length to 18"
Rotational Speed	Dependent upon the diameter
Signal Data Rate	
Electrical	DC to 50 Mb/s NRZ
Optical	50 Mb/s to 1.32 Gb/s per optical channel
Number of Circuits	Application and space dependent
Power	To 480 V; hundreds of amps

*\*Designed to customer specifications.*

**Note:**

Slip ring designs within these general specifications may be for either military or commercial applications. Military slip ring designs require specific licensing for export.

## AC2690 – slip ring

## AC259 – brush block

### Miniature Slip Ring Separate Assemblies

#### Description

Sometimes a self-contained “capsule” slip ring is not practical due to system size constraints or cost limitations. We can provide the slip ring (rotor) and brush block (stator) as separate components to be mated by the customer in their system. The rotor is supplied in a drum configuration which features consecutive individual rings along the axis of rotation. Miniature separates may have slip ring rotor diameters less than 0.100 inch.

A slip ring can be used in any electro-mechanical system that requires unrestrained, intermittent or continuous rotation while transmitting power and/or data. It can improve mechanical performance, simplify system operation and eliminate damage-prone wires dangling from movable joints. Applications are only limited by your imagination.



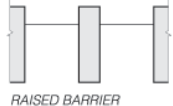

#### Options Available

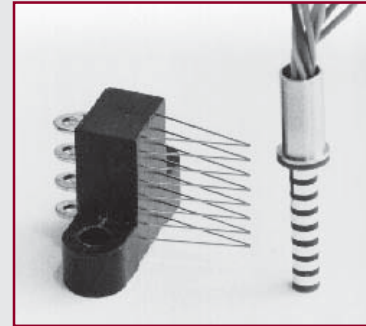
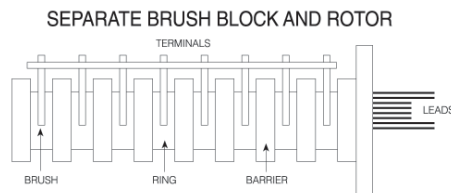
##### Slip Ring

- Raised barrier (.110 diameter)
- V-groove (90°) in each ring

##### Brush Block

- Flying leads
- Gold or tin plated terminals

OPTIONS	
RING GROOVE GEOMETRY	TYPE OF BRUSH
 <p>V-GROOVE</p>	 <p>WIRE</p>
 <p>RAISED BARRIER</p>	
 <p>FLAT BARRIER</p>	



#### Typical Applications

- Instrumentation
- Displays and avionics
- Testing and measuring
- Custom machinery
- OEM machinery
- Missile weapon systems
- Rate javelin

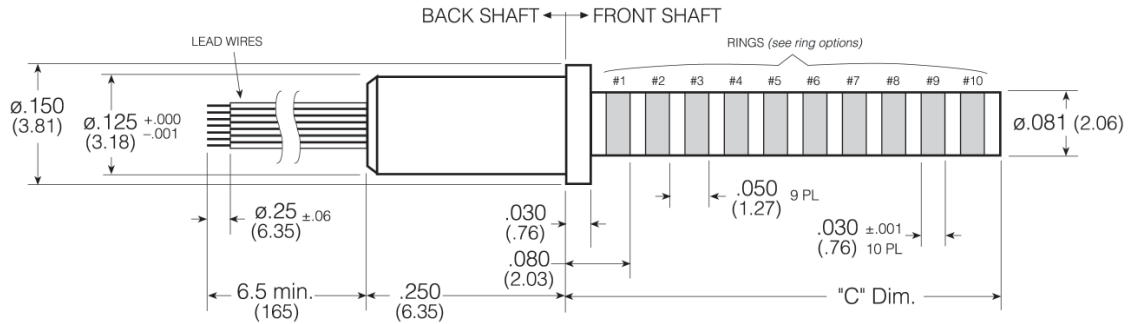
## Slip Ring Separate: AC2690

### Materials:

- Contact surface - 24K nickel hardened gold
- Backshaft - 303 stainless steel
- Leads - #30 AWG silver plated copper, Teflon® insulated
- Dielectric - plastic (mineral filled epoxy)
- A voltage of 1000V RMS 60Hz shall be applied between all circuits for a period of 10 seconds without breakdown

Teflon® is a registered trademark of E.I. du Pont de Nemours and Co.

Part Number	Number of Circuits	Dimension "C"	Lead Wire Color Codes	
AC2690-1	1	0.100 (2.54 mm)	#1	Brown
AC2690-2	2	0.150 (3.81)	#2	Red
AC2690-3	3	0.200 (5.08)	#3	Orange
AC2690-4	4	0.250 (6.35)	#4	Yellow
AC2690-5	5	0.300 (7.62)	#5	Green
AC2690-6	6	0.350 (8.89)	#6	Blue
AC2690-7	7	0.400 (10.16)	#7	Violet
AC2690-8	8	0.450 (11.43)	#8	Gray
AC2690-9	9	0.500 (12.7)	#9	White
AC2690-10	10	0.550 (13.97)	#10	Black

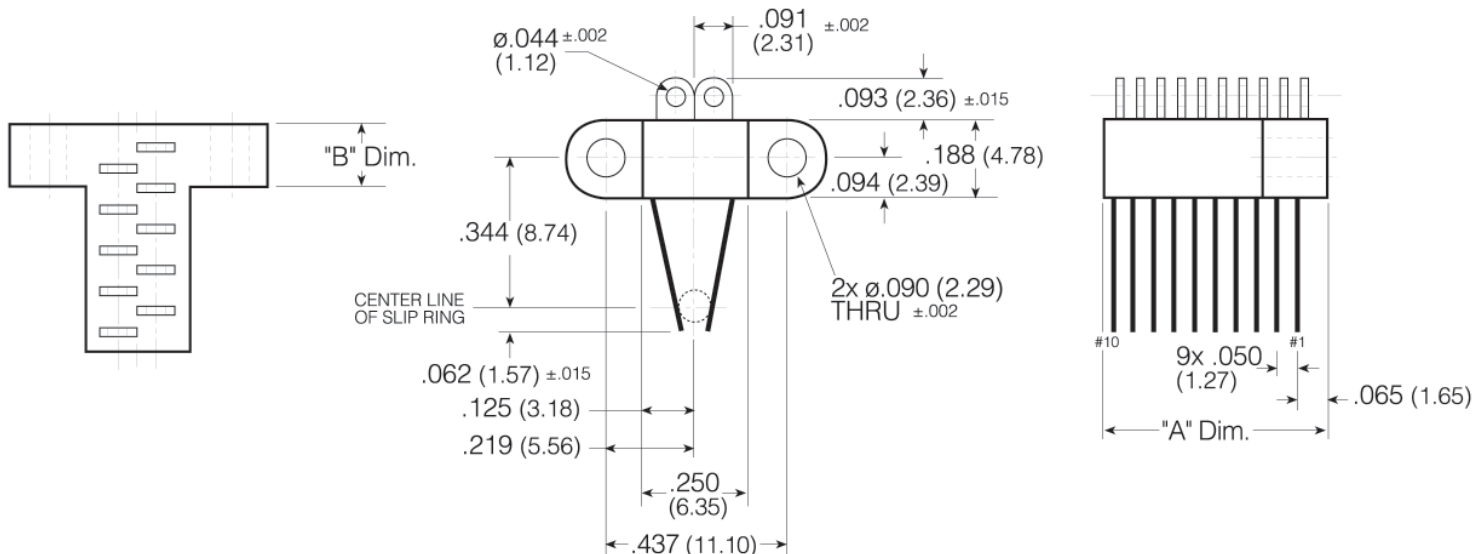


## Brush Block Separate: AC259

### Materials:

- Brushes - palladium alloy (ASTM B540) (.007 dia.)
- Plastic - polyester
- Terminals - .015 thick brass, silver (gold or tin optional) plated
- Flying leads optional
- A voltage of 1000V RMS 60Hz shall be applied between all circuits for a period of 10 seconds without breakdown
- Brush contact pressure approx. 5 grams when positioned on .081 dia. ring (AC2690-)

Part Number	Number of Circuits	Dimension "A"	Dimension "B"
AC259-1	1	0.100 (2.54 mm)	0.100 (2.54 mm)
AC259-2	2	0.140 (3.56)	0.140 (3.56)
AC259-3	3	0.190 (4.83)	0.156 (3.96)
AC259-4	4	0.240 (6.10)	0.156 (3.96)
AC259-5	5	0.290 (7.37)	0.156 (3.96)
AC259-6	6	0.340 (8.64)	0.156 (3.96)
AC259-7	7	0.390 (9.91)	0.156 (3.96)
AC259-8	8	0.440 (11.18)	0.156 (3.96)
AC259-9	9	0.490 (12.45)	0.156 (3.96)
AC259-10	10	0.540 (13.72)	0.156 (3.96)



Dimensions are in inches (millimeters)

## **MD6038 – slip ring**

## **MD6043 – brush block**

### *Miniature Slip Ring Separates with Bore Through*

#### **Description**

A slip ring can be used in any electromechanical system that requires unrestrained, continuous rotation while transferring power and / or data from a stationary to a rotating structure. A slip ring is also called a rotary electrical interface, commutator, collector, swivel or a rotary joint.

Sometimes a self contained “capsule” is not practical due to size constraints or cost limitations, and a “separate” is the solution. The term separate indicates an individual rotor / brush block combination. If a separate rotor / stator approach is best for your application, consider our MD series.

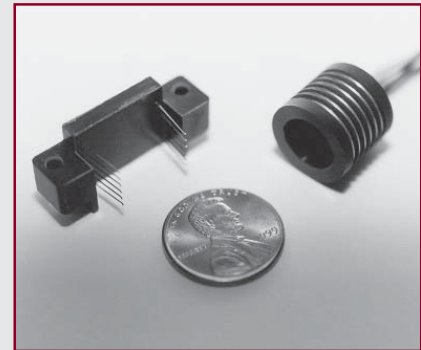
The MD series slip ring separate has 6 circuits and features a 3/8" unobstructed bore through the center that provides routing space for hydraulics, pneumatics, or for a concentric shaft mount.

#### **Features**

- 6 circuits
- 3/8" unobstructed bore. Other bore sizes also available.
- Gold-on-gold contacts. Provide enhanced conductivity and low noise.
- Excellent signal handling performance. Noise as low as 15 milliohms per circuit pair can be achieved at 60-100 rpm.

#### **Benefits**

- Improved system performance. Slip rings can improve mechanical performance, simplify system operation and eliminate damage-prone wires dangling from movable joints.
- Long Life. We use gold on gold contacts to extend unit life to exceed or meet the requirements for most commercial/industrial requirements.
- Over 6,000 designs. That's how many slip rings we've designed, so if this one's not right for your application, call us and tell us your specifications.



#### **Typical Applications**

This separate assembly provides high speed performance and an unobstructed bore through the center of the unit. It is successfully performing in instrumentation applications where miniaturization is critical, such as:

- Aircraft cockpit instruments
- Sputtering machines for the manufacture of integrated circuits
- Custom machinery
- OEM machinery
- Power tools

## Specifications

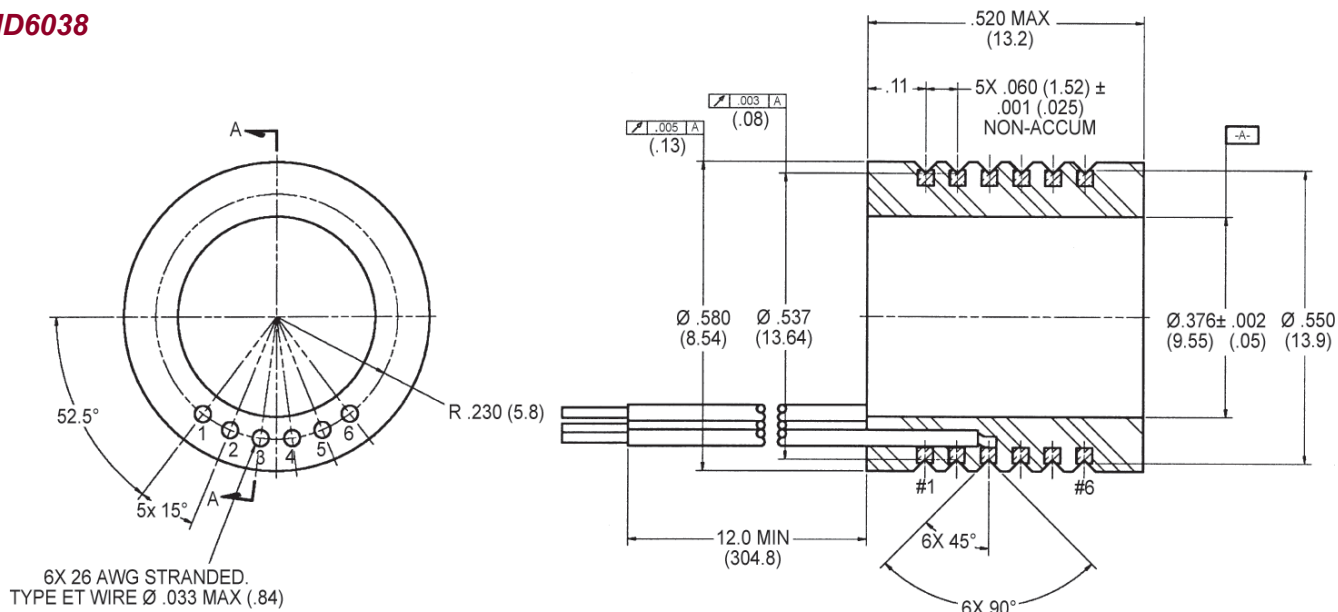
Ring O.D.	.550 (13.9)
Ring Pitch	.060 (1.52)
Bore	.376 (9.55)
Volts (Test)	500 VRMS

Ring Groove Geometry:  
 Raised Barrier  
 V-Groove

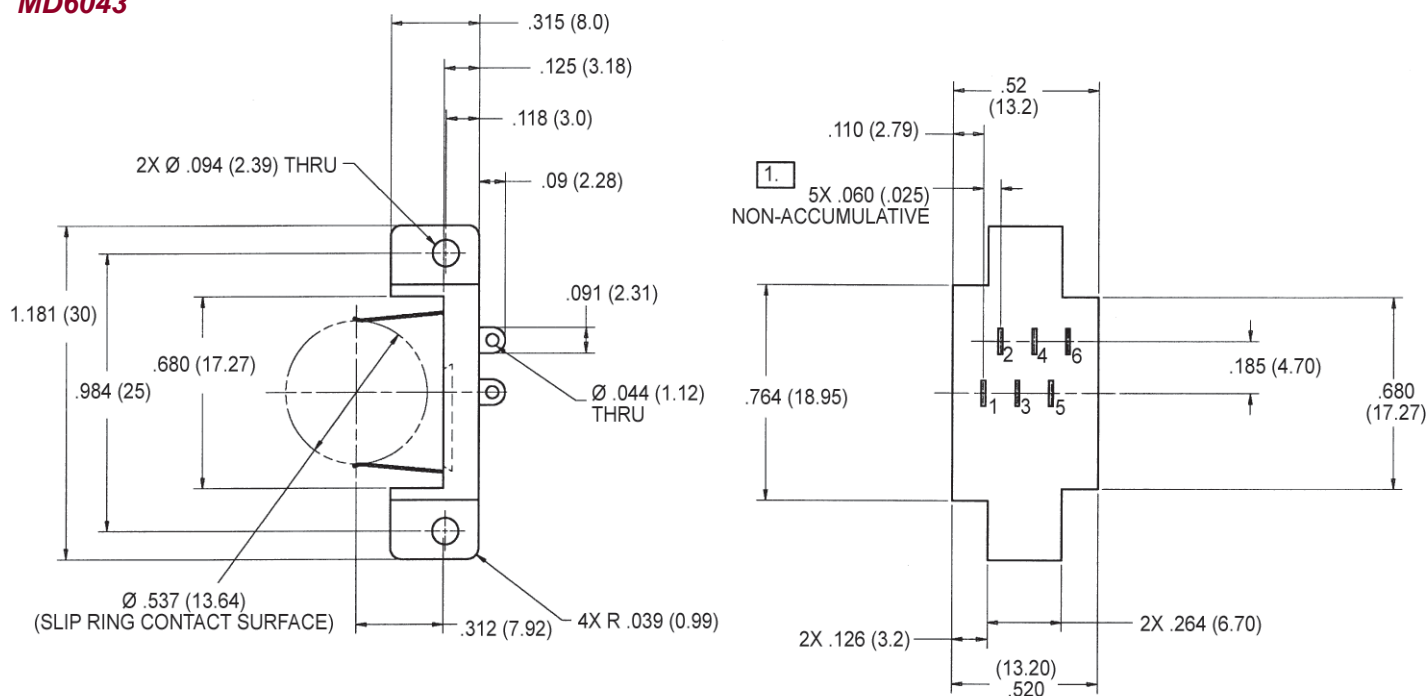
## Lead Wire Color Codes

Ring #	Color Code
#1	BLK
#2	BRN
#3	RED
#4	ORN
#5	YEL
#6	GRN

### MD6038



### MD6043



Dimensions are in inches (millimeters)

## Fiber Optic Rotary Joints

### Description

Fiber Optic Rotary Joints (FORJ) are to optical signals what electrical slip rings are to electrical signals, a means to pass signals across rotating interfaces. Moog Components Group has been producing electrical slip rings for over 50 years and has been producing FORJs for over twenty years. We are the world's leading supplier of rotary interfaces.

The information revolution and the speed of today's digital communications systems are straining the bandwidth limits of conventional slip ring technology. The electrical characteristics associated with conventional sliding contact slip rings limit their ability to effectively transfer data as the frequencies continue to increase. Insertion loss, electrical cross talk and signal quality degrade as the upper frequency limits are pushed higher and higher by increased bandwidth demands. However, optical channels have the ability to solve these copper-based problems.

The electrical problems encountered in the conventional slip ring do not exist in its optical counterpart. The insertion loss of the optical device is strictly a function of the optical wavelength used and is independent of the electrical frequency modulating the light source. Electrical cross talk in the copper slip ring is caused by the capacitance and inductance of the leads and rings; using optics eliminates these problems. Signals transmitted through wire lines produce magnetic fields that can cause electromagnetic interference in other circuits. Likewise, electromagnetic interference can induce unwanted signals (noise) into the slip ring's circuits. Optical fiber is a dielectric material, which means it is not affected by magnetic fields and does not produce interfering magnetic fields.

Our on-axis FORJ products are available as single fiber units or multiple fiber units with up to seven fibers. Products are available with multimode fiber, singlemode fiber or a combination of both types in the multi-fiber unit. If the centerline of rotation is available, we have your rotary solution.

When the centerline of rotation is not available, we have off-axis FORJs. These parts are available with bores from 4 to 44 inches and are multi-channel designs with bidirectional capability.

Moog Components Group has electrical slip rings technology that compliments our fiber optic rotary components technology and with these two product lines, we can provide a solution for almost any application. When you are ready to make the jump to light speed, give us a call.



### Typical Applications

- Radar antennas
- ROVs
- Robotics
- Medical systems
- Security systems
- Cable reels
- Marine propulsion systems
- Turrets



## AC6379

*Fiber optic rotary joint and slip ring various circuit configurations*

### Description

The AC6379 is a unique rotary component that can combine both a single channel Fiber Optic Rotary Joint (FORJ) and an electrical slip ring in the same mechanical assembly. This unique assembly has a single multimode fiber optic channel and can also have 24 electrical circuits rated at 2 amperes each.

The FORJ features the same expanded beam optical system that is used in our field proven FO3585 design. This system minimizes insertion loss and rotational variation in the optical system.

The slip ring section of the assembly is based on technology used in the AC6355 unit. The assembly features precision ball bearing for long life and is rated for continuous operation at speeds up to 250 RPM. The electrical section uses a gold-on-gold contact technology, which provides the ultimate in performance for demanding applications.

### Features

- Standard 24 circuit model with 2 amp circuits
- Precision ball bearing for long life
- Speeds up to 250 rpm continuous
- Compact size
- Sealed units available
- Metal housing available
- Transfer analog and digital signals
- Compatible with data bus protocols
- Single Fiber Optical Rotary Joint

### Benefits

- Unique signal handling performance with minimal electrical circuit noise
- Tight packaging to fit in the most demanding space constraints
- Low torque to minimize system torque budget
- Rapid delivery



### Typical Applications

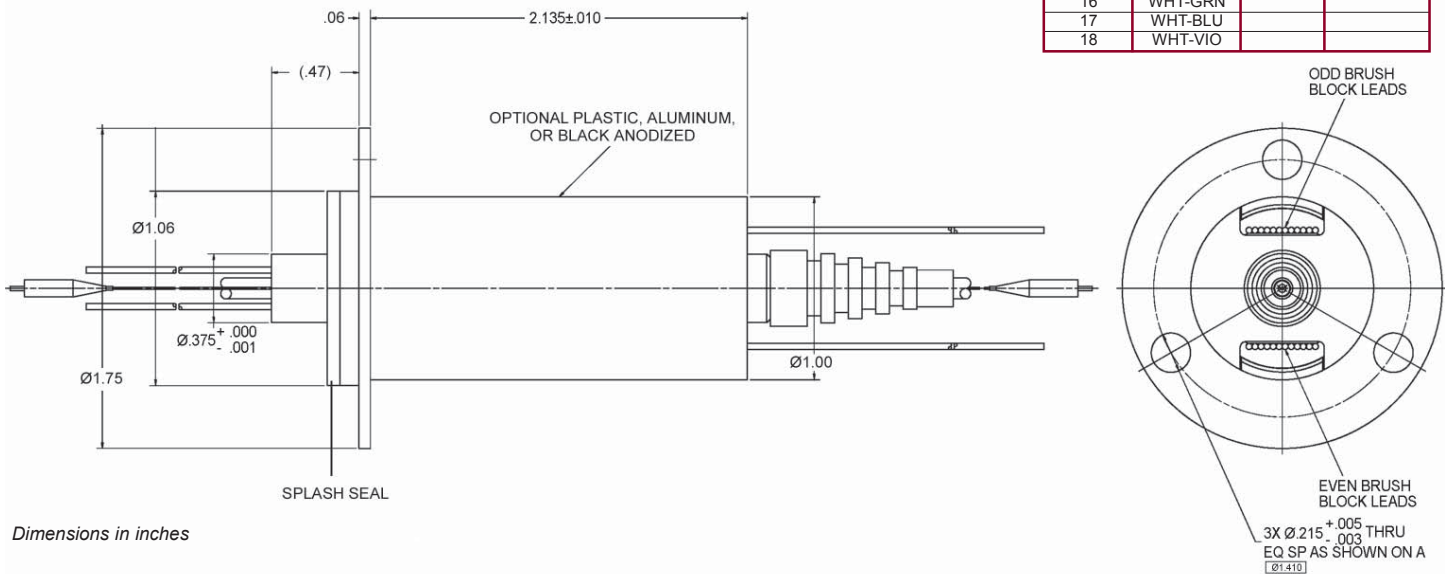
- Pan / tilt camera mounts
- Rotary index tables
- Rate tables
- Lighting
- Robotics

# Fiber Optic Rotary Joint (FORJ)

Specifications		Options
Operating Speed	250 rpm max. connectors	
Circuit Configurations	24 @ 2 amp	
Lead Length	24 inch (600 mm) optical and electrical +100 / 0 mm	• 48 inch (1200 mm)
Voltage	210 VDC	
Operating Temp.	-40°C to +80°C	
Contact Material	Gold-on-gold signal; silver	• Gold
Housing	Plastic	• Aluminum, black anodized
Lead Size / Type	Elec. 2 amp, 26 AWG Optical 62.5 / 125 / nm multimode with 2 mm jackets	
Dielectric Strength	250 VAC @ 60 Hz, between each circuit and all other circuits	
Insulation Resistance	1000 megohms max tested @ 500 VDC	
Electrical Noise	60 milliohms max when tested @ 6VDC 50 milliamps when running @ 10 rpm	
Optical Insertion Loss	3.5 dB max. at 850 nm and 1300 nm	
Return Loss	-20 dB min.	
Optical Connectors	ST	• FC

2 amp leads will be color coded

Ring #	Color	Ring #	Color
1	BLK	19	BLK
2	BRN	20	BRN
3	RED	21	RED
4	ORN	22	ORN
5	YEL	23	YEL
6	GRN	24	GRN
7	BLU		
8	VIO		
9	GRY		
10	WHT		
11	WHT-BLK		
12	WHT-BRN		
13	WHT-RED		
14	WHT-ORN		
15	WHT-YEL		
16	WHT-GRN		
17	WHT-BLU		
18	WHT-VIO		



Dimensions in inches

## FO4698

### *Low Cost Fiber Optic Rotary Joint*

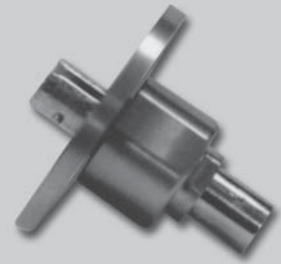
#### **Description**

The FO4698 is a Moog Components Group entry-level single channel fiber optic rotary joint. This part offers good optical loss performance at an affordable price. The unit is very compact in size and features direct ST connection. The unit will work with both multimode and singlemode fibers.

The FO4698 fiber optic rotary joint must be used with ST style fiber optic connectors with ceramic ferrules. Length of the ferrule cannot exceed the dimension shown below. Use of other type and / or length ferrules will degrade performance and could destroy the part.

#### **Features**

- Provides rotary coupling for fiber link
- No collimating lens used
- Quick and easy hook-up to ST
- Completely bidirectional



#### **Typical Applications**

- Security systems
- Medical systems
- Other clean environments
- Robotics

# Fiber Optic Rotary Joint (FORJ)

Specifications		
Insertion Loss*	MAX dB	Variation dB
Fiber Size (Microns): 50 / 125	4	2
62.5 / 125	3	1
9 / 125	4	1
Side Loading	1 pound maximum (continuous)	
Sealing	None	
Rotation Rate	100 rpm	
Operating Temperature	- 55° C to + 60° C	
Life	One million revolutions	

\* Loss values are for Moog Components Group terminated cable assemblies

## Notes:

1. Hard mount one side only. **Hard mounting both sides will destroy the bearings.**
2. Modifications to the basic design are possible to alter or enhance operating characteristics. Consult factory for specific applications.

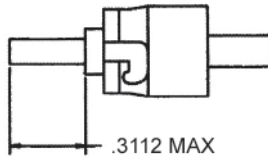
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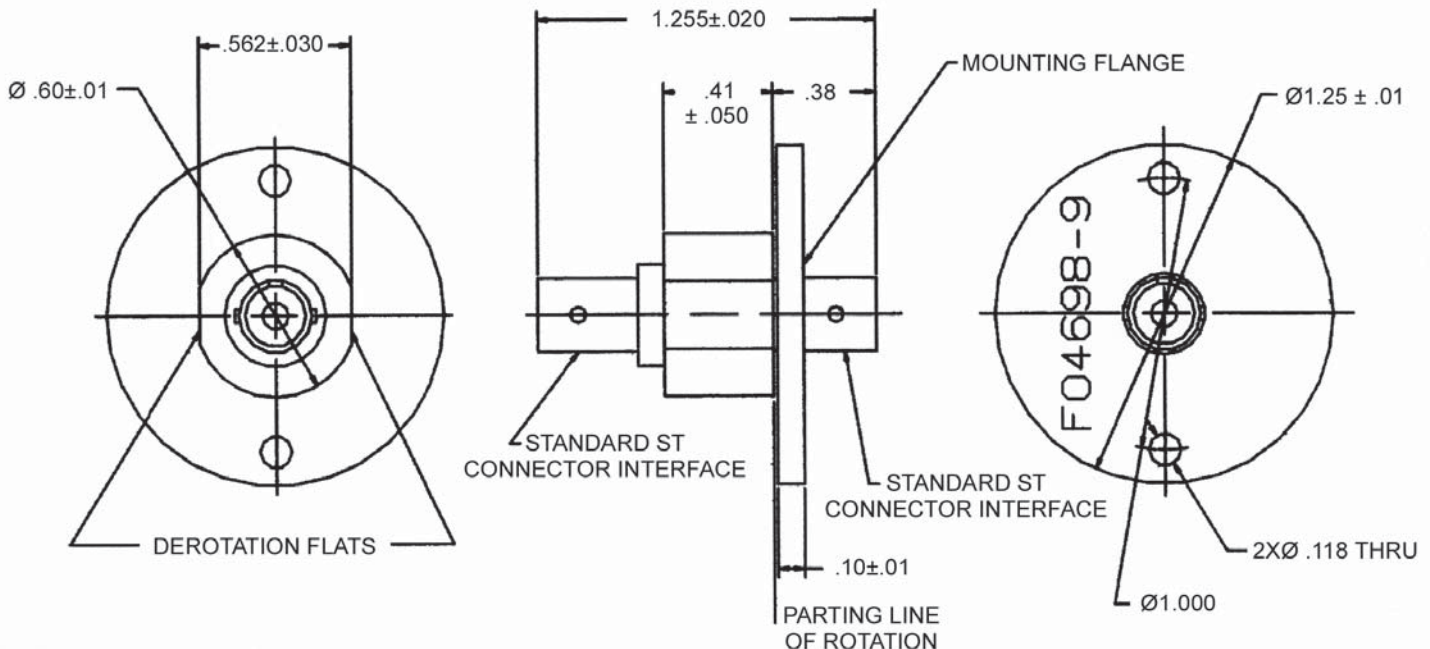
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## Application Notice:

The FO4698 fiber optic rotary joint must be used with ST style fiber optic connectors with ceramic ferrules. Length of the ferrule cannot exceed the dimension shown below. Use of other type and/or length ferrules will degrade performance and could destroy the part.



## ST Style



## FO3585

### *On-Axis Fiber Optic Rotary Joint*

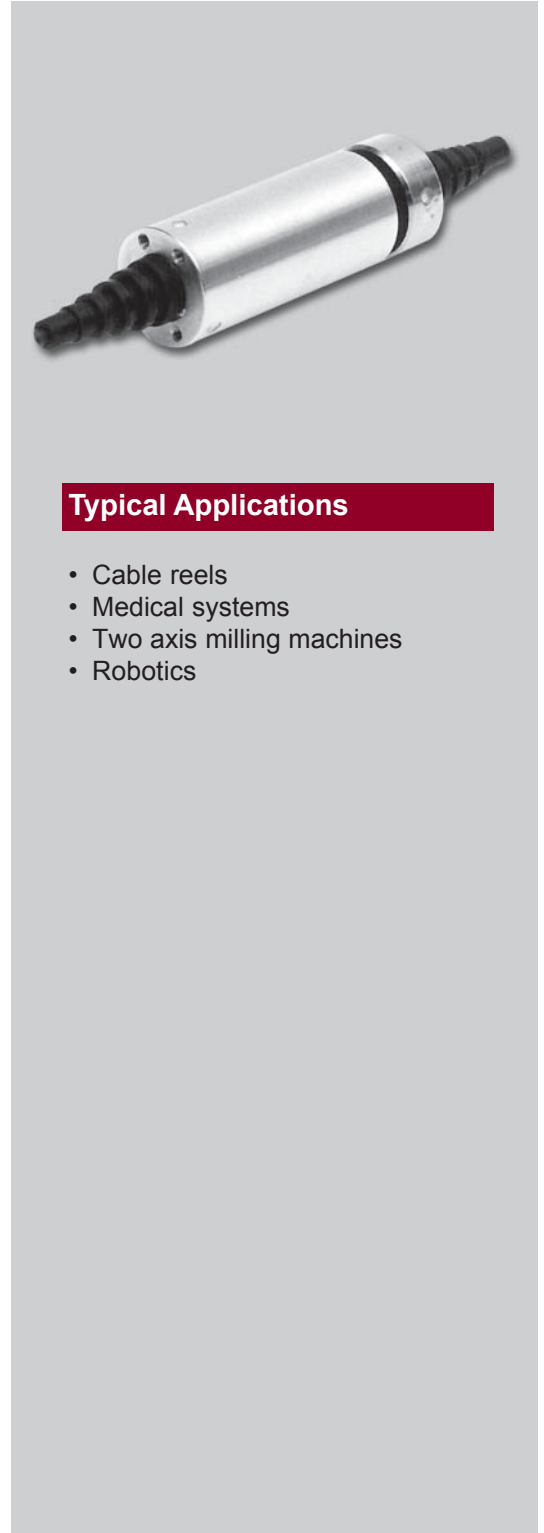
#### **Description**

The FO3585 is our ruggedized single channel multimode fiber optic rotary joint. This part was designed to withstand the most severe environments and has a demonstrated history in both commercial and military applications. The design features an expanded beam optical system to provide minimum insertion loss and rotational variation.

The assembly can be produced with pigtails lengths tailored to the customer's application. Most popular optical connectors are available with this product; please consult the factory about your specific needs. Additional options for this part include mounting flanges and drive pins.

#### **Features**

- Provides rotary coupling for multimode fiber links
- Wide operating wavelength range for wavelength multiplexing
- Completely bidirectional
- Available in wide range of fiber sizes and pigtail lengths
- Can be integrated into existing slip ring designs
- Environmentally sealed



#### **Typical Applications**

- Cable reels
- Medical systems
- Two axis milling machines
- Robotics

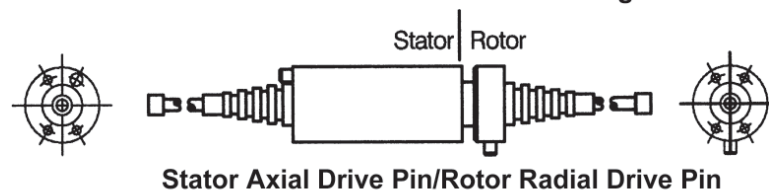
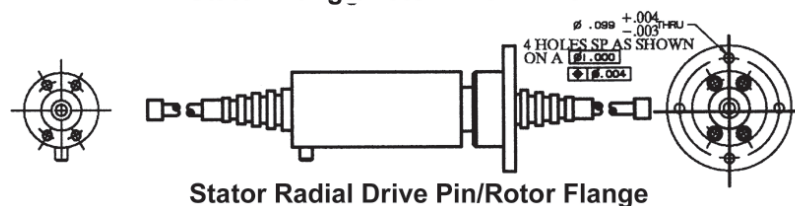
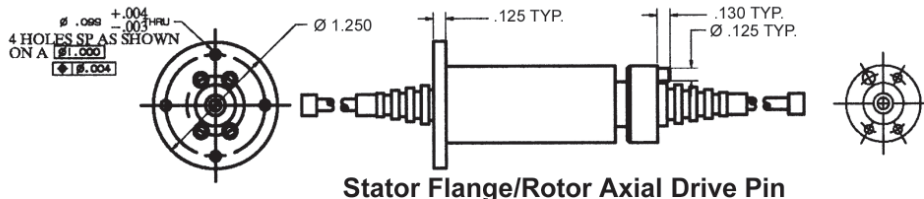
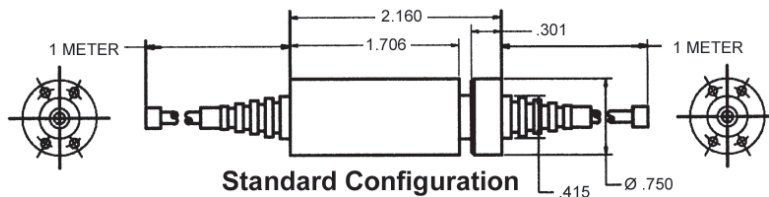
# Fiber Optic Rotary Joint (FORJ)

Specifications		Options
Operating Wavelength	830 or 1300 nanometers (customer specified)	
Insertion Loss*	MAX dB	Typical Variation dB
Fiber Size (Microns):	50 / 125	3.0
	62.5 / 125	3.0
	100 / 140	2.5
	200 / 240	2.0
Torque	2.0 in-oz	
Side Loading	5 pounds maximum (continuous)	
Bend Radius	1.0 inch minimum	
Sealing	Environmental	
Rotation Rate	1000 rpm (without seals)	
Operating Temp.	-55° C to +85° C	
Life**	200 million revolutions	
Vibration*	MIL-STD-202 method 201A simple harmonic motion, 0.03 inch amplitude, 10 - 55 Hz	
Shock*	MIL-STD-202 method 213 test condition 1, 100g's, 6ms duration, sawtooth waveform	

- Flange PIN: 3585015001
- Drive PIN: 3585015000

\* These are minimum performance values to which the design has been subjected. More severe levels are within the design limits.  
 \*\* The operational life of the unit may vary depending upon individual operating parameters, environment, temperature and other factors.

**Notes:**  
 Modifications to the basic design are possible to alter or enhance operating characteristics. Consult factory for specific applications.  
 All dimensions are in inches and tolerances unless otherwise specified are .xxx=±.005 .xx=±.01



## FO5706

### *Fiber Optic Rotary Joint*

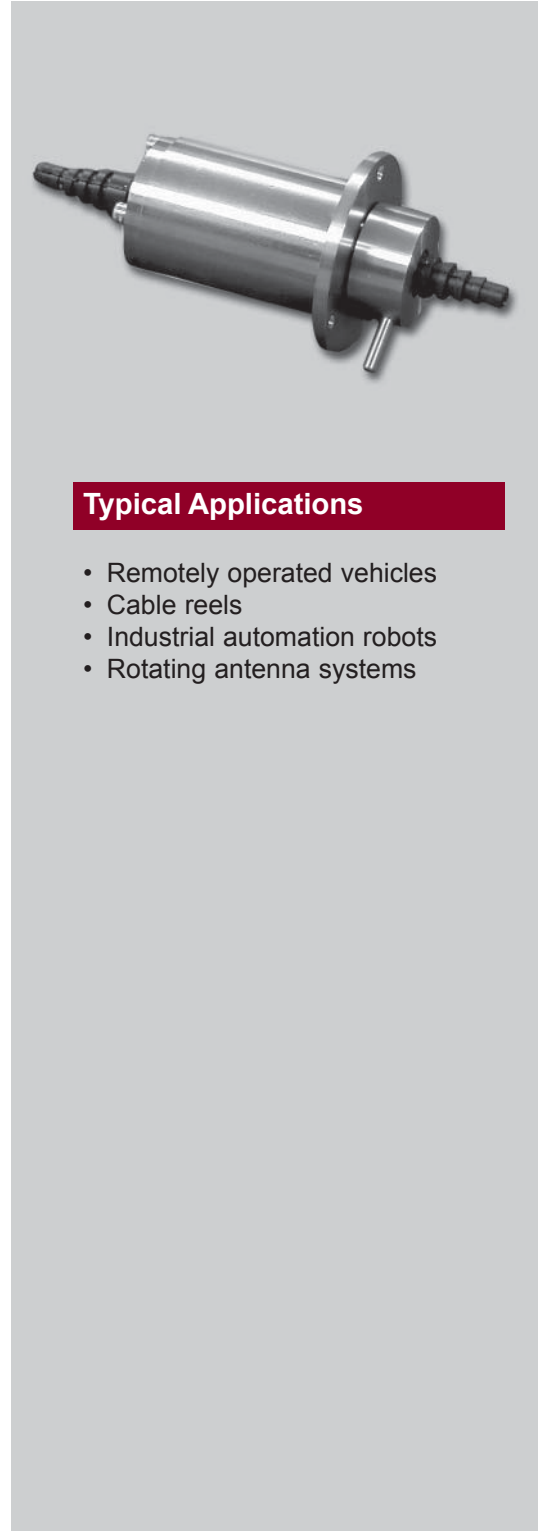
#### **Description**

The FO5706 is a cost effective singlemode fiber optic rotary joint. It features low insertion loss and good back reflection characteristics at an affordable price. The unit was designed for the demanding requirements of marine environments, which means it has good environment seals, a broad operating temperature range and good immunity to shock and vibration.

The assembly can be produced with pigtail lengths tailored to the customer's application. Most popular optical connectors are available with this product; please consult the factory about your specific needs.

#### **Features**

- Provides rotary coupling for singlemode fiber link
- Passive bidirectional device
- Can be integrated into existing slip ring designs
- Available with custom pigtail lengths up to 3 meters in length
- Environmentally rugged design; stainless steel housing



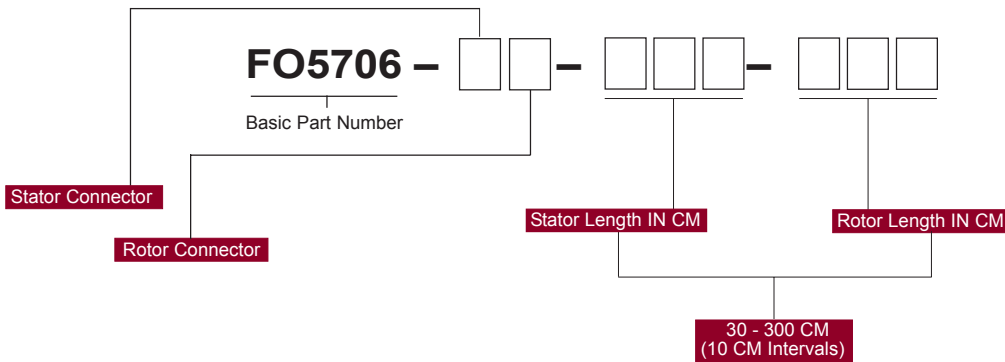
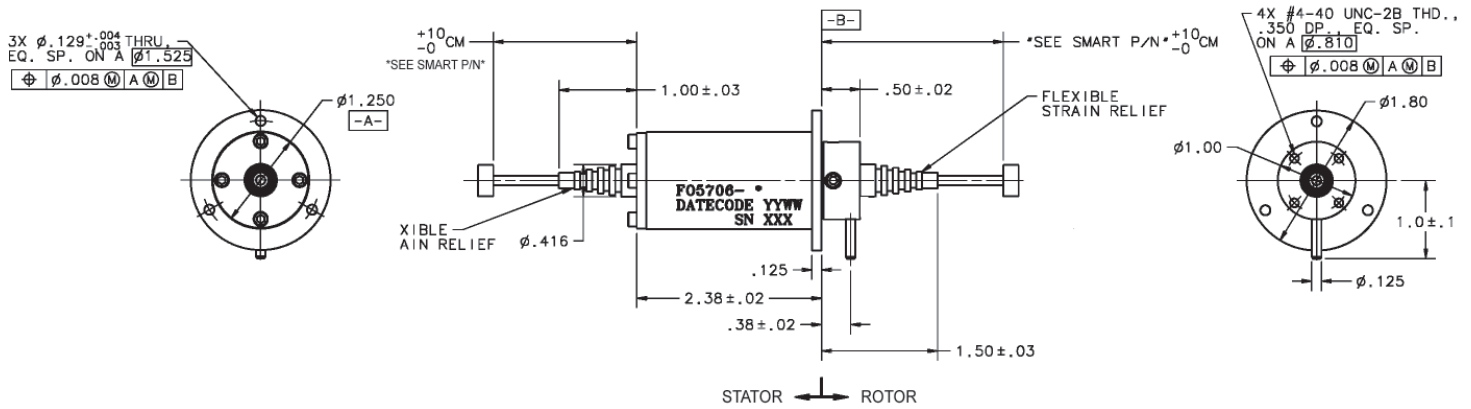
#### **Typical Applications**

- Remotely operated vehicles
- Cable reels
- Industrial automation robots
- Rotating antenna systems

# Fiber Optic Rotary Joint (FORJ)

Specifications	
Fiber Size	9 / 125um
Operating Wavelength	1310 and / or 1550 nm
Insertion Loss	3.5 dB maximum
Back Reflection	-20 dB minimum
Temperature	-20 to 80 degrees C
Rotation Rate	120 rpm maximum
Exterior Surfaces	Stainless steel
Sealing	IP65
Vibration	Tested to Mil-STD-202, method 204, Condition A, 0.06 inch amplitude, 10-500 Hz
Shock	Tested to Mil-STD-202, method 213, Condition A, 509 / 11ms / 1/2 sine

\* All dimensions are in inches and tolerances unless otherwise specified are:  
 .xxx = ±.005    .xx = ±.01    .x = ±.03





## FO5707

### *Multi-Pass Fiber Optic Rotary Joint*

#### **Description**

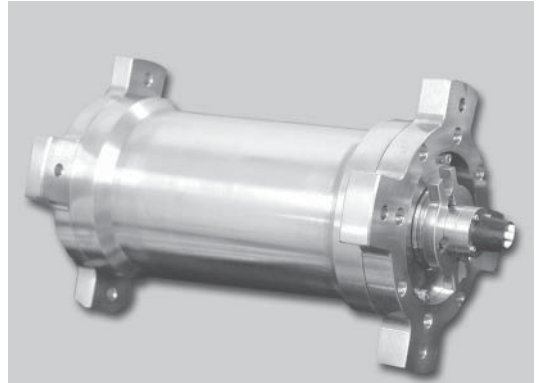
Our FO5707 multi-channel on-axis fiber optic rotary joint is a unique part with many patented features. This compact assembly is available with 2 to 7 optical circuits, which can be singlemode, multimode or a combination of both fiber types.

This assembly's features make it an ideal solution when one fiber cannot carry all the required information. Its low insertion loss, less than 4.5 dB and good back reflection performance, less than -20 dB, make it ideal for use in both laser and LED based optical systems. The broad optical bandwidth of the device, 800 to 1550 nm for multimode applications and 1300 to 1550 nm for singlemode applications, make it suitable for systems using wavelength division multiplexing.

The concentric fiber design of this fiber optic rotary joint allows its physical form factor to remain the same regardless of the number of optical channels selected.

#### **Features**

- 2 to 7 single or multimode channels
- Constant physical size for 2 to 7 channels
- Rugged design:
  - Mil-STD-167-1 ship vibration
  - Mil-STD-202F shock
  - Marine grade stainless steel exterior surfaces
- Uniform loss, regardless of the number of channels



#### **Typical Applications**

- ROVs
- Radar antennas
- Cable reels
- Hydrophone streamers

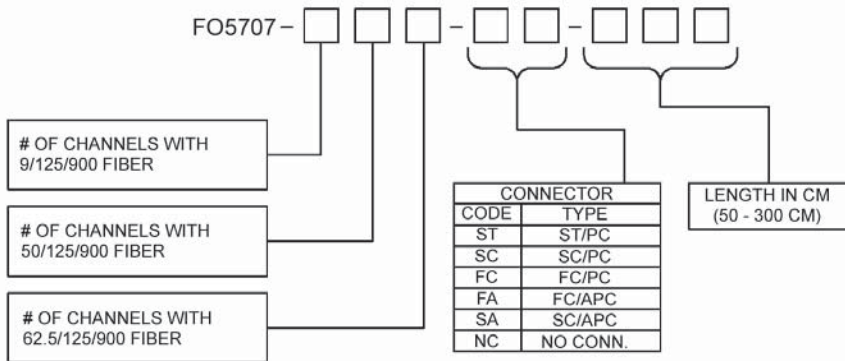
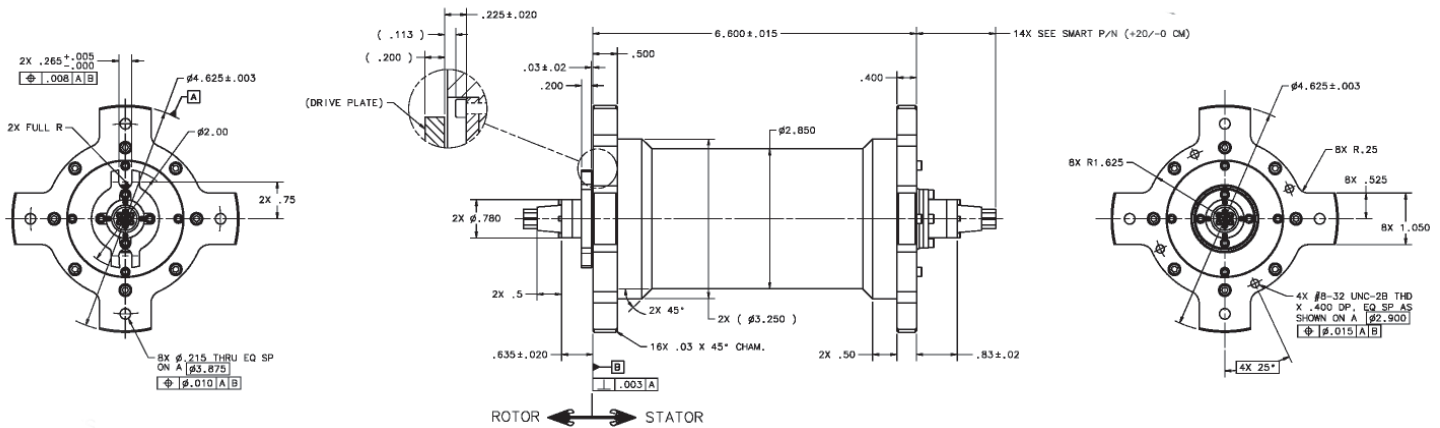
# Fiber Optic Rotary Joint (FORJ)

## Specifications

Cable Jacket	3mm diameter Kevlar Reinforced PVC		
Max. Insertion Loss (db)	850nm LED	1310nm Laser	1550nm Laser
Fiber Size (microns): 9/125/900	---	4.5	4.5
50/125/900	3.5	2.5	---
62.5/125/900	3.5	2.5	---
Back Reflection	-20 dB minimum		
Rotation Rate	To 120 RPM		
Temperature	-20 to +80 deg. C		
Vibration	Tested to MIL-STD-167-1 (ships)		
Shock	Tested to MIL-STD-202F		

\* All dimensions are in inches and tolerances unless otherwise specified are:

.xxx = ±.005 .xx = ± .01 .x = ± .03



**Note:** Modifications to the basic design are possible to alter or enhance operating characteristics. Consult factory for specific applications.

## FO3595

### *Off-Axis Fiber Optic Rotary Joint*

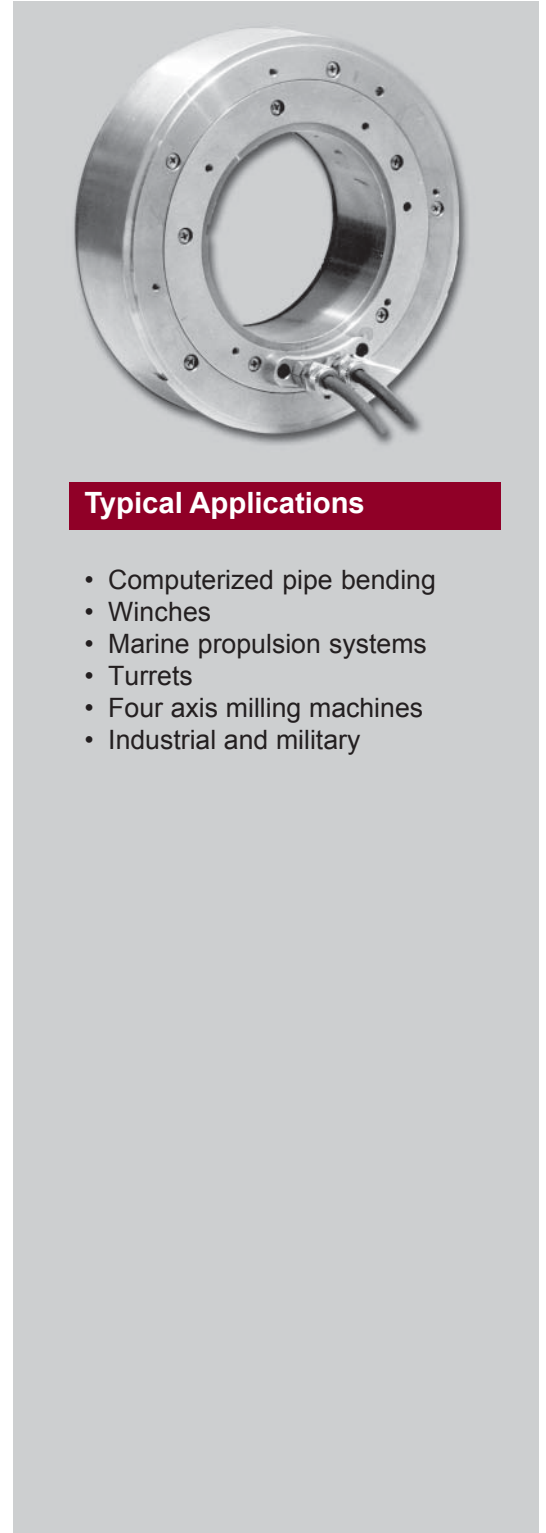
#### **Description**

When the centerline of rotation must be occupied by some other device, Moog Components Group has an off-axis fiber optic rotary for those unique applications. While these designs are not as simple to use as the on-axis devices, they do allow off-axis rotary systems to achieve very high data rates.

The FO3595 is our basic off-axis fiber optic rotary joint offering. The design has a four inch through bore and can have as many as six bidirectional optical circuits. The design also features an optional integral two circuit electrical slip ring. Moog Components Group offers the unique electronics required to pass signals through this device. If you are interested in an off-axis FORJ, please contact our applications engineers for assistance.

#### **Features**

- Provides rotary coupling for multimode fiber links
- Completely bidirectional
- The unit may be hard mounted to either the inner or outer housing and soft mounted or de-rotated on the opposite housing using the built-in features

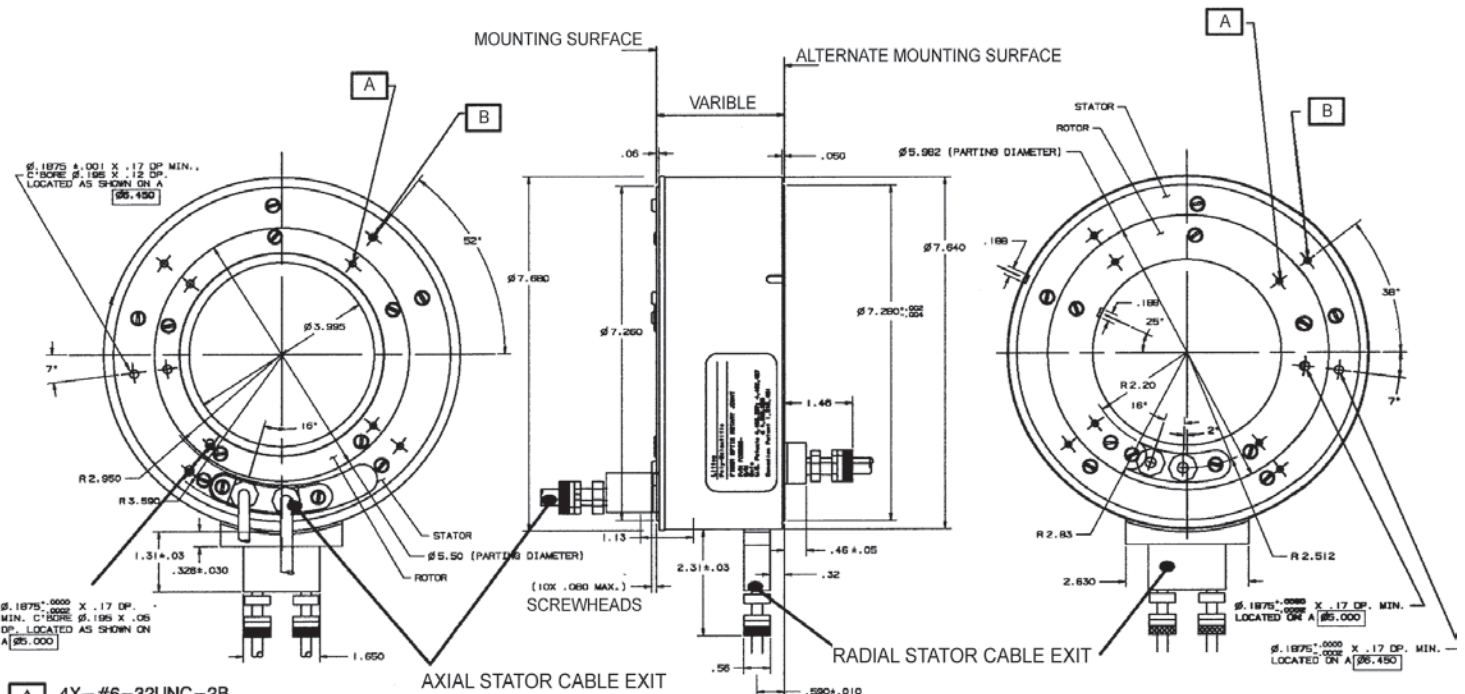


#### **Typical Applications**

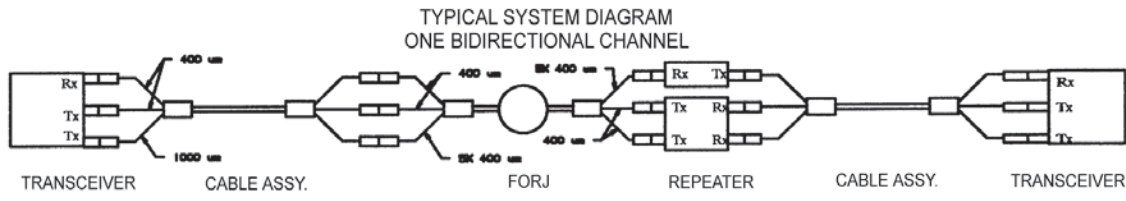
- Computerized pipe bending
- Winches
- Marine propulsion systems
- Turrets
- Four axis milling machines
- Industrial and military

# Fiber Optic Rotary Joint (FORJ)

Specifications		Options
Data Rate	50MBITS / sec NRZ max	<ul style="list-style-type: none"> <li>Cable exits radially or axially on stator housing</li> <li>Optical bidirectional channels (1-6)</li> <li>Internal electrical slip ring (1 bidirectional optical and 4 electrical circuits (3A))</li> <li>Customer specified pigtail length (2 meters max)</li> <li>Heater for extended low temperature operation</li> </ul>
Torque	1 ft-lb max	
Side Loading	5 pounds maximum (continuous)	
Bend Radius	2.0 inch minimum	
Sealing	Environmental	
Rotation Rate	60 rpm max	
Operating Temperature	-0°C to +71°C	
Thermal Shock	MIL-STD-810 method 503.1	
Vibration	MIL-STD-810 method 514.2 Figure 514.2-2 curve F	
Shock	MIL-STD-810 method 516.2 procedure I Figure 516.2-2, 30 g's, 11ms duration	
Humidity	MIL-STD-810 method 507.1 procedure II	



- A** 4X-#6-32UNC-2B LOCATED ON Ø5.00
- B** 4X-#6-32UNC-2B LOCATED ON Ø6.450



**Notes:**  
 Modifications to the basic design are possible to alter or enhance operating characteristics. Consult factory for specific applications.  
 All dimensions are in inches and tolerance is ± 0.01 unless otherwise noted.

## Large Bore Slip Rings With Optics

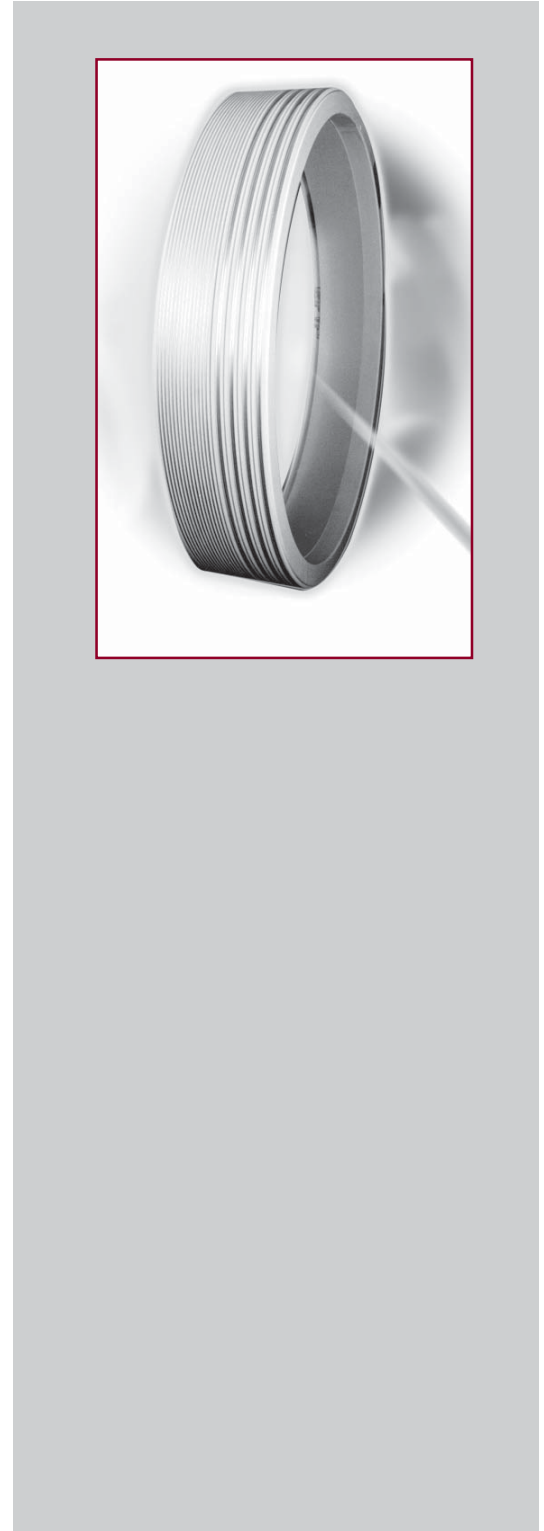
### Description

Moog Components Group large bore slip rings represent the union of manufacturing processes and technologies that enable us to offer large, high quantity slip rings with advanced features that are cost effective. The manufacturing processes allow the slip ring to be built in an optimum assembly fashion, which significantly reduces delivery time and price.

The design features traditional sliding contact technology for the transfer of power and control signals utilizing Moog Components Group fiber brush technology. The fiber brush technology's low contact force provides extremely long life while producing minimal wear debris, compared to composite-type graphite brushes. Fiber brushes are quieter than composite brushes, for those applications where low audible noise is important.

Moog Components Group large slip rings also feature optical channels for high-speed digital communications, up to 1.32 Gb/s. This patented technology also has the capability to transfer multiple optical signals per optical channel, resulting in data transfer rates in excess of 5 Gb/s per optical channel. The technology is also scalable to accommodate various data handling requirements and is capable of communicating in both directions across a rotary interface. These last two features greatly increase design flexibility and capability.

Applications for these advanced products include medical CT scanners, luggage scanners, cranes, offshore mooring, amusement rides or any application requiring a large bore slip ring assembly.



Specifications*	
Size Range	ID to 50"; length to 18"
Rotational Speed	Dependent upon the diameter
Signal Data Rate	
Electrical	DC to 50 Mb/s NRZ
Optical	50 Mb/s to 1.32 Gb/s per optical channel
Number of Circuits	Application and space dependent
Power	To 480 V; hundreds of amps

\*Designed to customer specifications.

# Aerospace | Military Slip Ring Products



## AC264

## AC267

### *Miniature slip ring capsules in various circuit configurations*

#### **Description**

A slip ring capsule can be used in any electromechanical system that requires unrestrained, intermittent or continuous rotation while transferring power and / or data.

Miniature slip ring capsule assemblies economically address both critical space and weight limitations. Each assembly includes the rotor, brush blocks, frame, ball bearings and dust cover. Existing designs are available or we can custom design slip rings to meet your specific requirement.

Although originally designed for commercial uses, the miniature slip ring capsule is well suited for many military applications.

#### **Features**

- Rugged stainless steel housing
- Up to 60 rings can be packaged in a self-contained envelope 1.957" long and .50" barrel diameter.
- Gold-on-gold sliding contact technology
- Up to 100 rpm operation
- Low noise. As low as 25 milliohms
- Long life. Several million total revolutions at speeds up to 60 rpm have been obtained

#### **Benefits**

- Precise, tight packaging capabilities for meeting stringent design criteria
- Proprietary plating techniques provide improved reliability, longer life and increased efficiency
- Unique signal handling performance to minimize noise and increase speed
- Configuration flexibility allows for packaging from 16 to 60 circuits



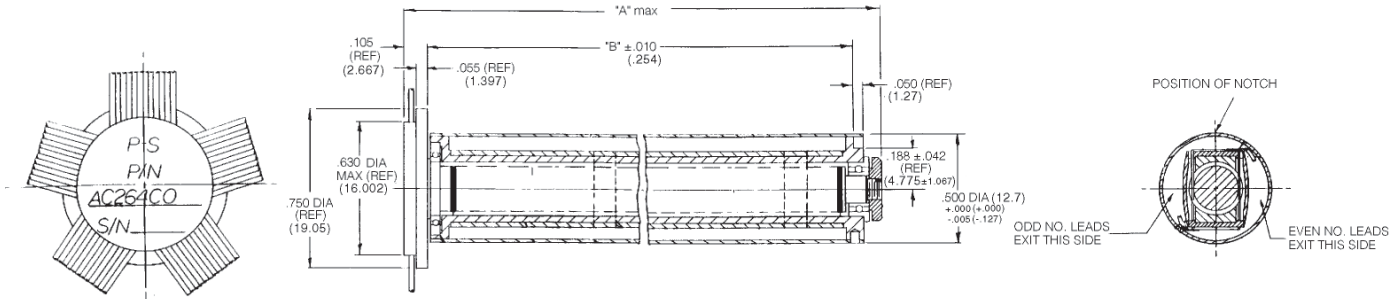
#### **Typical Applications**

This slip ring provides high speed performance and is successfully serving in various applications such as:

- Gimballed pitch, roll and yaw axes of inertial navigation systems
- Satellite de-spin assemblies
- Missile weapon systems
- Unmanned aerial vehicles (UAV)
- Virtual reality systems

# Miniature Slip Ring Capsules

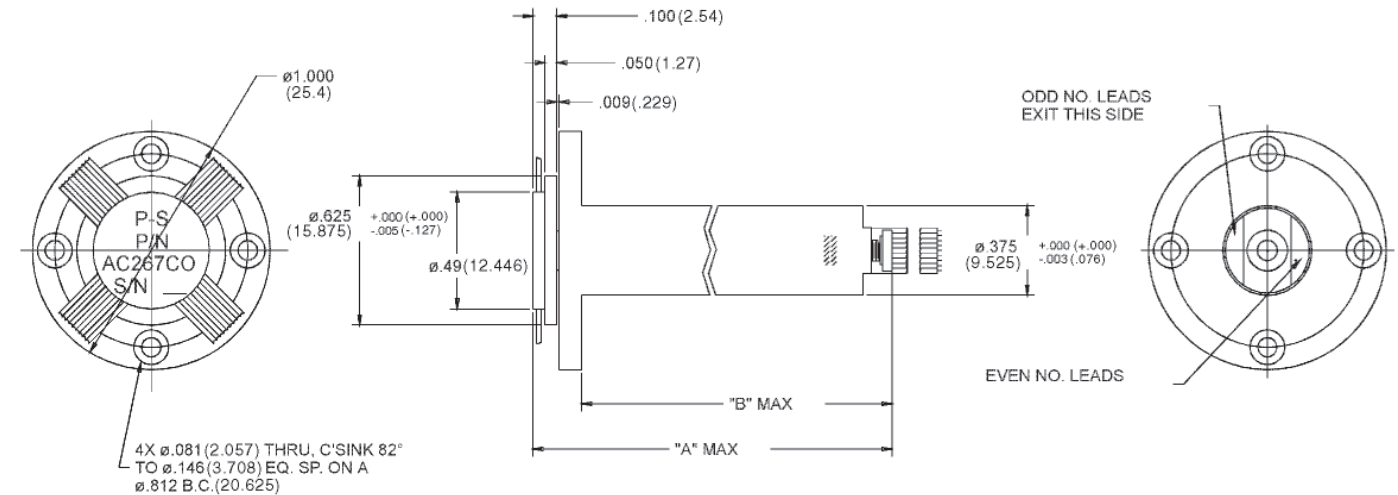
## AC264



Specifications	
Current Rating	.8 amp per circuit
Lead Size	30 AWG
Dielectric Strength	500 VAC
Isulation Resistance	1000 mohms @ 500 VDC
Circuit Resistance	265 mohms with 12" leads both ends
Starting Torque	2 grams-centimeters max per circuit
Noise	50 mohms tested @ 5 rpm test current 50 MA

No. of Circuits	"A" Dimension	"B" Dimension
20	1.04 (26.3)	0.757 (19.2)
30	1.34 (33.9)	1.057 (26.8)
40	1.64 (41.5)	1.357 (34.5)
50	1.94 (49.1)	1.657 (42.1)
60	2.24 (56.8)	1.957 (49.7)a

## AC267



Specifications	
Current Rating	.8 amp per circuit
Lead Size	30 AWG
Dielectric Strength	500 VAC
Isulation Resistance	1000 mohms @ 500 VDC
Circuit Resistance	270 mohms with 12" leads both ends
Starting Torque	1.5 grams-centimeters max per circuit
Noise	25 mohms tested @ 5 rpm with test current 100 MA

No. of Circuits	"A" Dimension	"B" Dimension
16	0.91 (23.2)	0.71 (18.0)
20	1.03 (26.2)	0.83 (21.0)
24	1.15 (29.3)	0.95 (24.1)
28	1.27 (32.3)	1.07 (27.1)
32	1.39 (35.4)	1.19 (30.2)
36	1.51 (38.4)	1.31 (33.2)

\* Dimensions are in inches (millimeters)



## AC6292

### *Miniature Slip Ring Capsule - Circuit configuration for commercial and military applications*

#### **Description**

A slip ring capsule can be used in any electromechanical system that requires unrestrained, occasional or continuous rotation while transferring power and / or data.

Miniature slip ring capsule assemblies economically address both critical space and weight limitations. Each assembly includes the rotor, brush blocks, frame, ball bearings and dust cover.

These slip rings can be configured with spacing between rings of 0.006 inch and brush diameters no larger than a human hair. Existing designs are available or we can custom design slip rings to meet your specific requirement.

#### **Features**

- Center-to-center adjacent ring spacings as small as 0.015 inch can be obtained
- 80 rings packaged in a self-contained envelope 3.3" inches long and 1.5" inch barrel diameter
- Gold-on-gold sliding contact technology
- Up to 40 rpm operation
- Low noise; as low as 15 milliohm per circuit pair
- Long life; several million total revolutions have been obtained

#### **Benefits**

- Precise, tight packaging capabilities for meeting stringent design criteria
- Proprietary plating techniques provide improved reliability, longer life and increased efficiency
- Unique signal handling performance to minimize noise and increase speed
- Other configurations are available from 16 to 95 circuits
- We also manufacture commercial slip rings from 6 to 56 circuits

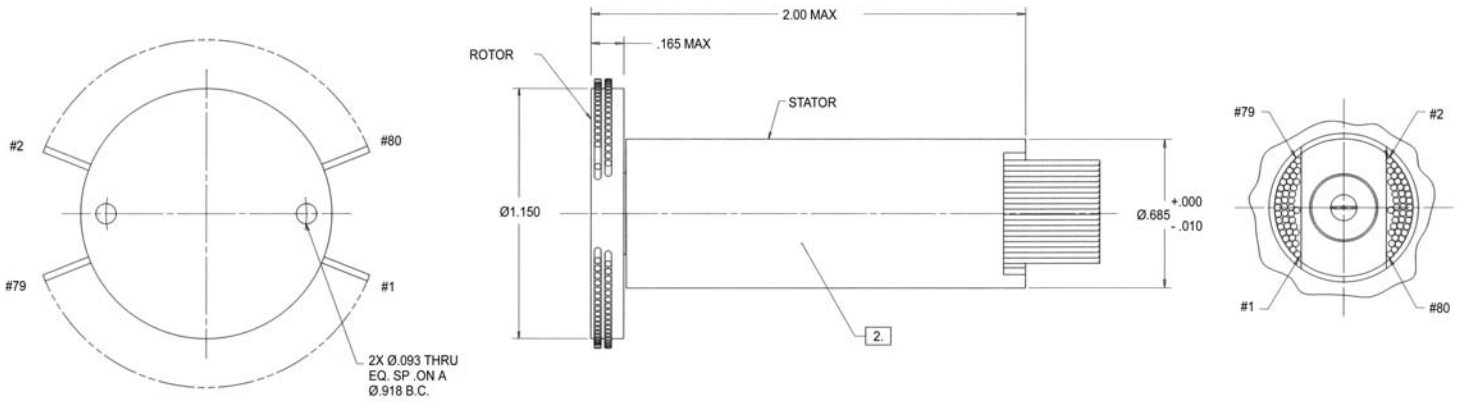


#### **Typical Applications**

- Gimballed pitch, roll and yaw axes of inertial navigation systems
- Deep earth drilling projects
- Missile weapon systems
- Unmanned aerial vehicles (UAV)
- Airborne camera platforms

# Miniature Slip Ring Capsules

Specifications	
Current Rating	0.8 amp per circuit
Lead Size	30 AWG
Dielectric Strength	1000 V (test)
Insulation Resistance	1000 megohms
Circuit Resistance	0.27 ohms (leads @ 24")
Starting Torque	240 gm cm
Noise	30 milliohms max.
Rotational Speed	40 rpm max.
Lead length	24 inches each end



Dimensions are in inches (millimeters)

## RK4288

### *Miniature Slip Ring Capsule Circuit configuration for commercial and military applications*

#### **Description**

A slip ring capsule can be used in any electromechanical system that requires unrestrained, occasional or continuous rotation while transferring power and / or data.

Miniature slip ring capsule assemblies economically address both critical space and weight limitations. Each assembly includes the rotor, brush blocks, frame, ball bearings and dust cover.

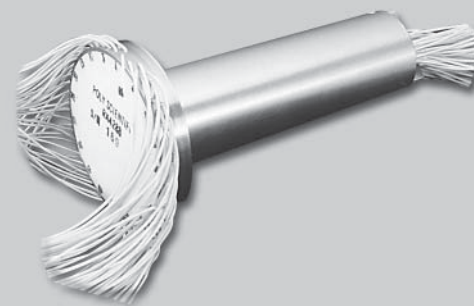
These slip rings can be configured with spacing between rings of 0.015 inch and brush diameters no larger than a human hair. Existing designs are available or we can custom design slip rings to meet your specific requirement.

#### **Features**

- Center-to-center adjacent ring spacings as small as 0.015 inch can be obtained
- 95 rings packaged in a self-contained envelope 3.3" inches long and 1.5" inch barrel diameter
- Gold-on-gold sliding contact technology
- Up to 40 rpm operation
- Low noise; as low as 15 milliohm per circuit pair
- Long life; several million total revolutions have been obtained

#### **Benefits**

- Precise, tight packaging capabilities for meeting stringent design criteria
- Proprietary plating techniques provide improved reliability, longer life and increased efficiency
- Unique signal handling performance to minimize noise and increase speed
- Other configurations are available from 16 to 80 circuits
- We also manufacture commercial slip rings from 6 to 24 circuits



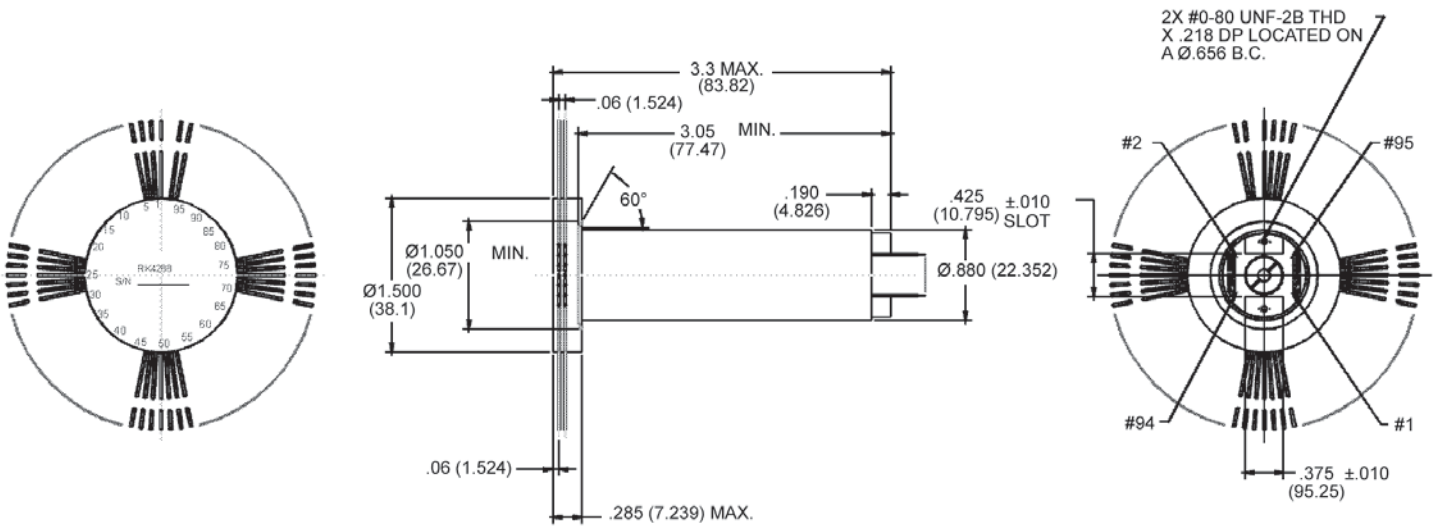
#### **Typical Applications**

This slip ring provides high speed performance and is successfully serving in applications such as:

- Gimballed pitch, roll and yaw axes of inertial navigation systems
- Satellite de-spin assemblies
- Deep earth drilling projects
- Missile weapon systems
- Unmanned aerial vehicles (UAV)
- Airborne camera platforms

# Miniature Slip Ring Capsules

Specifications	
Current Rating	0.8 amp per circuit
Lead Size	30 AWG
Dielectric Strength	1000 V (test)
Insulation Resistance	1000 megohms
Circuit Resistance	0.27 ohms (leads @ 24")
Starting Torque	240 gm cm
Noise	30 milliohms max.
Rotational Speed	40 rpm max.
Lead length	24 inches each end



Dimensions are in inches (millimeters)

# Miniature Slip Ring Capsules

Part Number	No. of Ckts	Signal	Power	Length	O.D. Housing	O.D. Flange	Other
RT4922	5	5 @ 1A	0	1.10"	0.47"	0.87	1 segmented circuit
SJ4834	8	5 @ 1A	3 @ 4A	1.90"	0.75"	1.56"	Integral rotor connector
RE4590	12	12 @ 1A	0	0.60"	0.38"	0.48"	10" lead length
JJ6095	15	15 @ 1A		1.1"	1.0"	1.4"	O'ring, sealed bearing. Fiber brush
GS2725	29	23 @ 0.5A	6 @ 2A	0.83"	0.39"	1.24"	Lead length is 11" min.
RE4815	32	32 @ 1A	0	1.32"	0.50"	0.60"	Lead length is 24" rotor & 12" stator
GS2388	38	38 @ 1A	0	1.0"	0.41"	1.26"	8" bb leads; 12" rotor leads
BB3199	39	39 @ 1A	0	1.03"	0.59"	0.65"	24/12" lead length
BB2759	45	45 @ 1A	0	1.03"	0.59"	0.65"	Rotor leads: 24"; Brush block leads 12"
NH3302	60	60 @ 1A	0	2.24"	0.50"	0.75"	Lead length is 12"
BB2871	65	65 @ 1A	0	1.28"	0.65"	0.64"	Higher voltage on 5 ckts
AC6449	74	66 @ 1A	8 @ 3A	1.26"	1.75"	2.25"	Concentric unit
AC6292	80	57 @ 1A	23 @ 3A	2.00"	0.68"	1.15"	COTS - export w/out license
RK4288	95	95 @ 1A	0	3.3"	0.88"	1.50"	Lead length is 24"

## Vehicular Slip Rings

*Reliable signal and power coupling in the most rugged battlefield conditions*

### Description

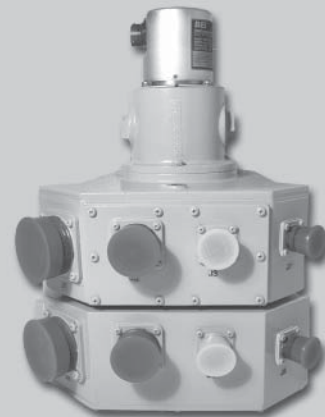
The increasing complexity of modern military vehicles demands slip rings that provide reliable electrical interfaces between the stationary and rotating parts of these vehicles. Moog Components Group slip rings have been chosen to operate on numerous vehicular programs to meet these challenges. M1 / 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 in this data sheet, or our engineer 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

Export of the items in this brochure is regulated by the U.S. Department of State. Buyer shall comply with these regulations.



### 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 Components Group 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 than 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 (e.g. 208 VAC) 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

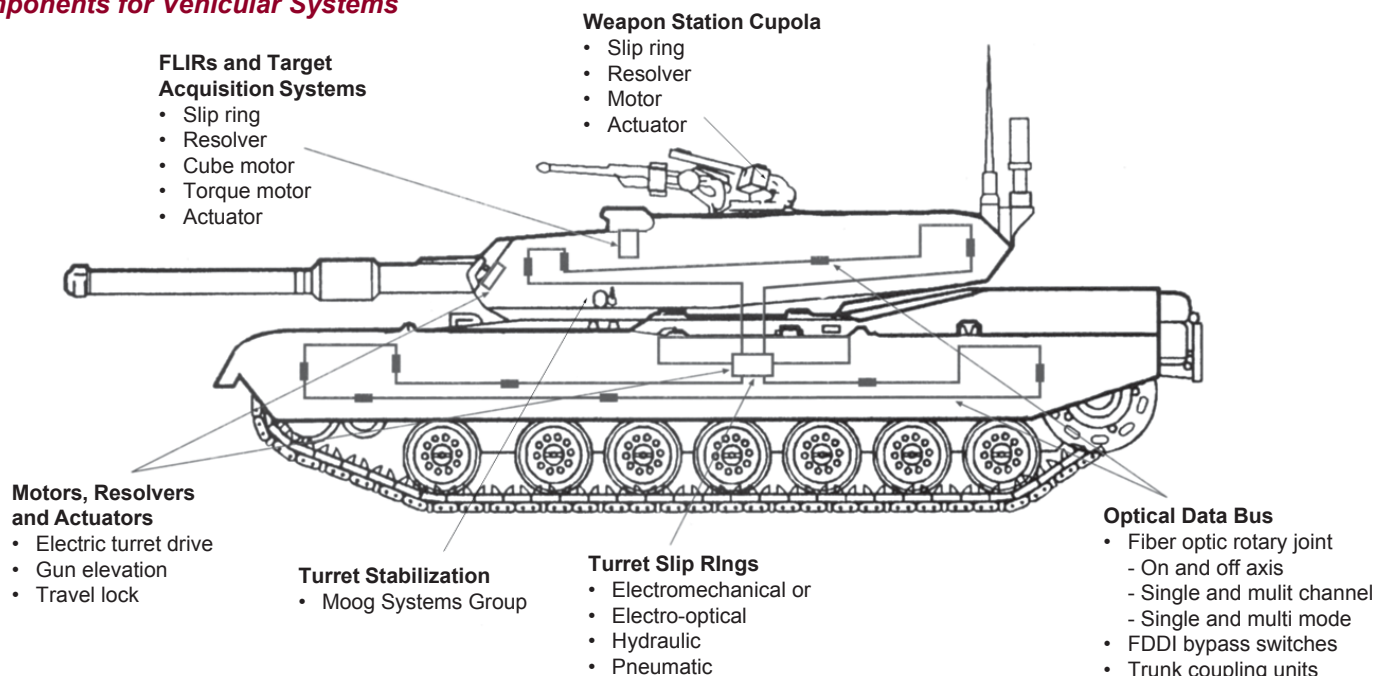
electrical isolation requirements have a significant impact on the design of the slip ring capsule. A typical vehicular slip ring will include circuits for powering electronic equipment, video circuits, and analog and digital control circuits.

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 rings 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 crewmembers' facemasks. 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

## Components for Vehicular Systems



# Vehicular Slip Rings

## VEHICULAR SLIP RING DESIGN CRITERIA

space requirements. These advances in military technology, plus many others, have challenged the capabilities of the slip ring industry, demanding equally sophisticated solutions for reliable vehicle operation.

Moog Components Group 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:

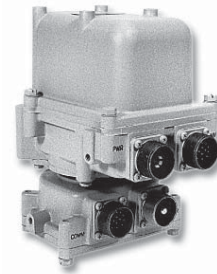
- Established a complete Research & Development team, conducting numerous on-going studies in such areas as

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 ISO 9001-2000.
- 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 over 30 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
- M60 A1 & A2
- HSTV
- M2 & M3 Bradley
- Leopard
- M48
- LAV
- 8x8
- M728 CEV
- Centurion
- Commando V150
- Stryker
- AAV
- Bionix



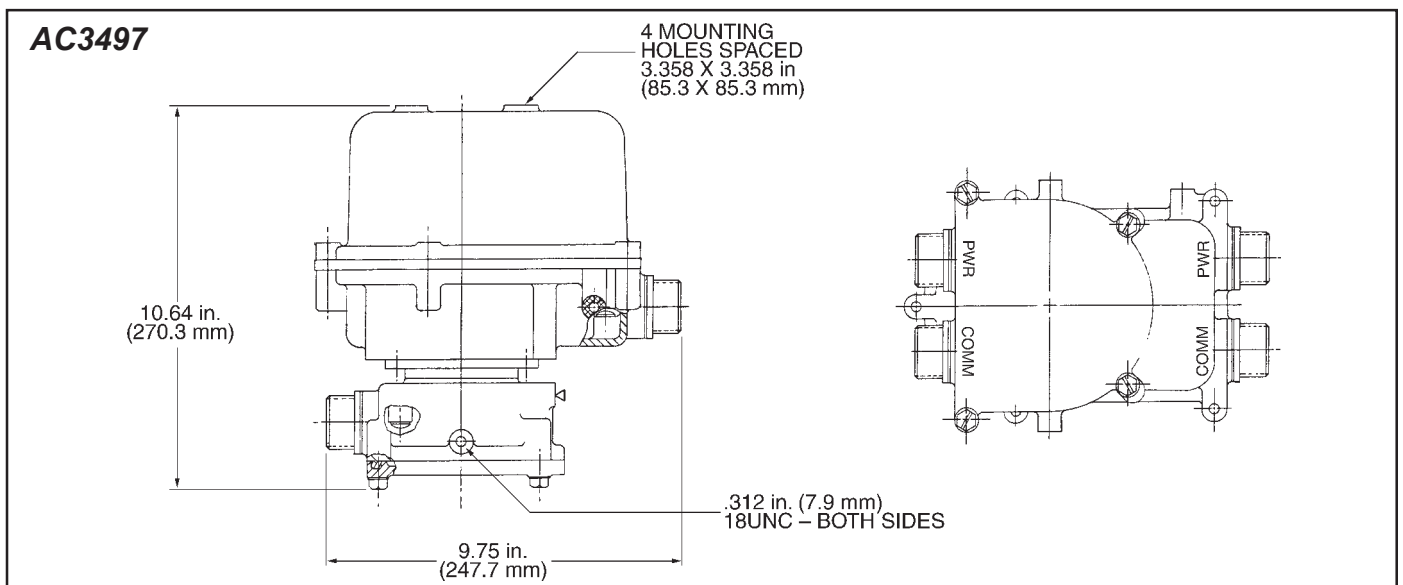
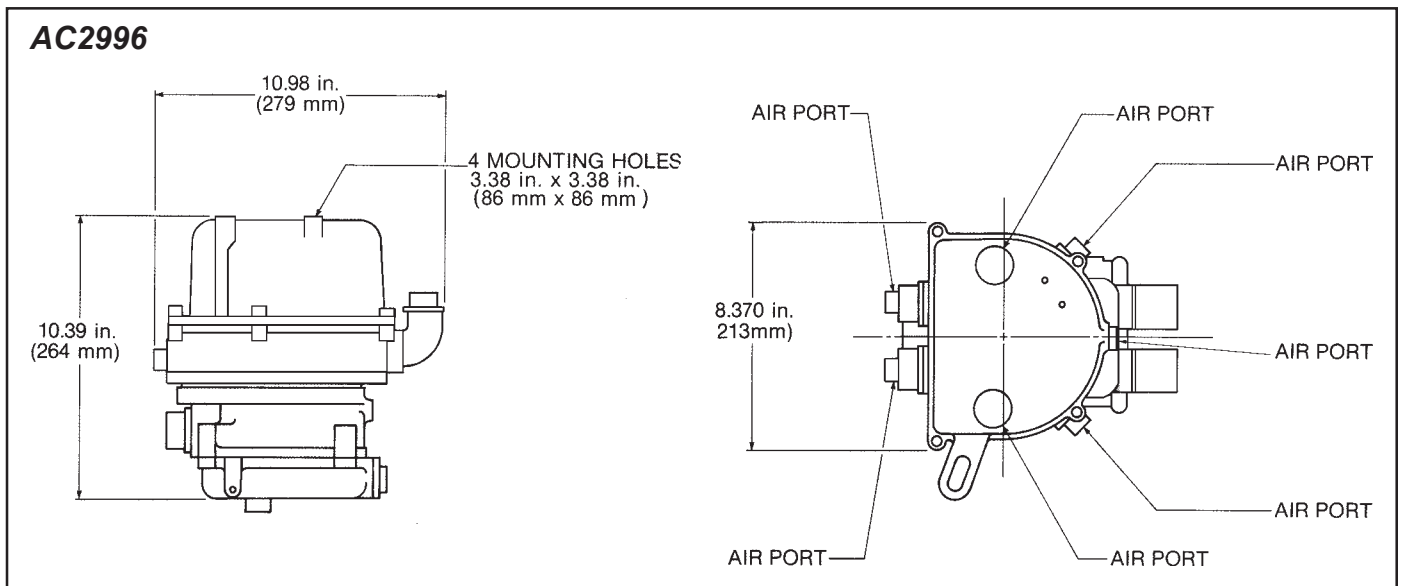
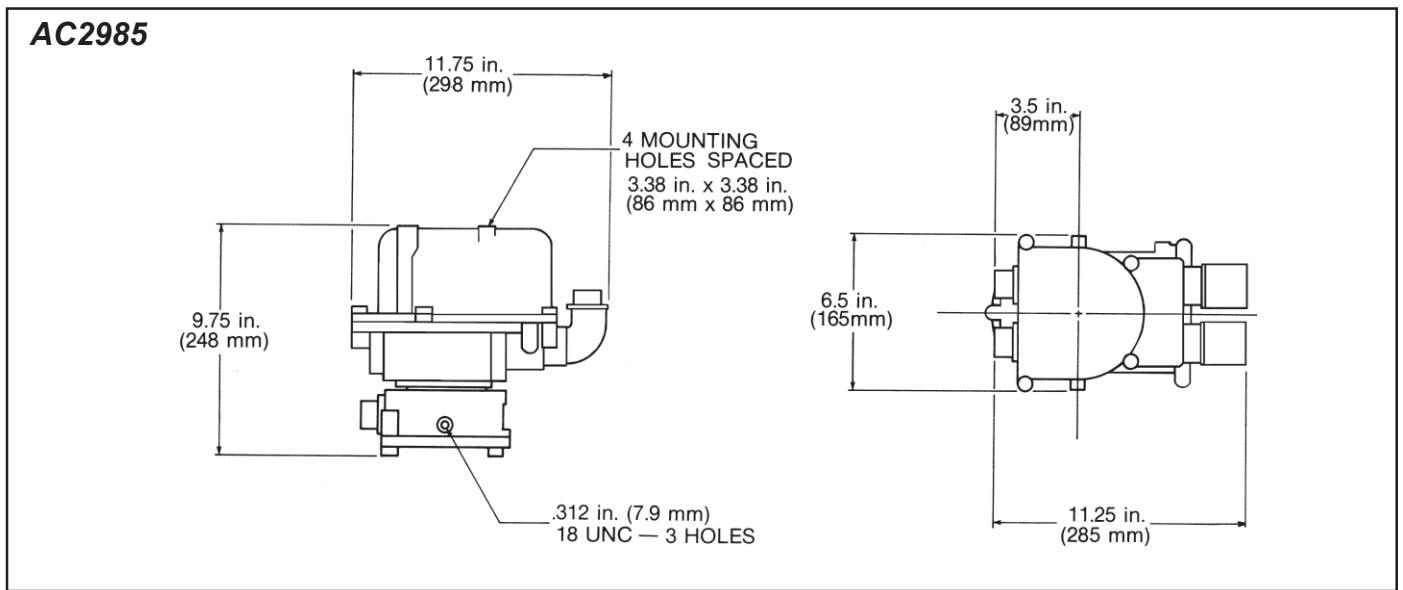
## Vehicular and Turret Slip Ring Specifications

The following table presents a cross-section of our vehicular designs. Tooling charges may apply to new orders.

Part Number	Power			Signal			Comments
	Number of Circuits	Cont. Current Rating	Voltage Rating	Number of Circuits	Gauge or Type	Intended Signal	
AC2985	1 1	150 amps 150 amps	150 V Peak Ground	12	Control	5 amps, 150 V	90° elbow connector mounting
AC3497	1 1	150 amps 150 amps	Ground	12	Control	5 amps, 150 V	2 cam design for dual fire control
JZ3733	2	200 amps	24 VDC	42	20 AWG	3 amps, 28 VDC	NBC air channel Size similar to JZ4994
JZ4994	4	200 amps	24 VDC	86	24 AWG	2–4 amps, 28 VDC	NBC air channel (2) 1553 Data-bus (8) RS-170 Video
JZ4906	2	200 amps	24 VDC	61	20 AWG	3 28 VDC, 28 VDC	NBC air channel Size similar to JZ4994
AK6057	2	250 amps	18-32 VDC	238	24 AWG	2–4 28 VDC, 28 VDC	EMI features concentric rings and high isolation
AC6033	1 1	150 amps 150 amps	Ground	18	Control	5 28 VDC	Dual cam NBC air channel
ED6405	2 2	450 amps 75 amps	28 VDC 28 VDC	150	28 AWG	100 Mbit Ethernet	Contains resolver, R to D network, power distribution network and pneumatic and hydraulic rotary joint

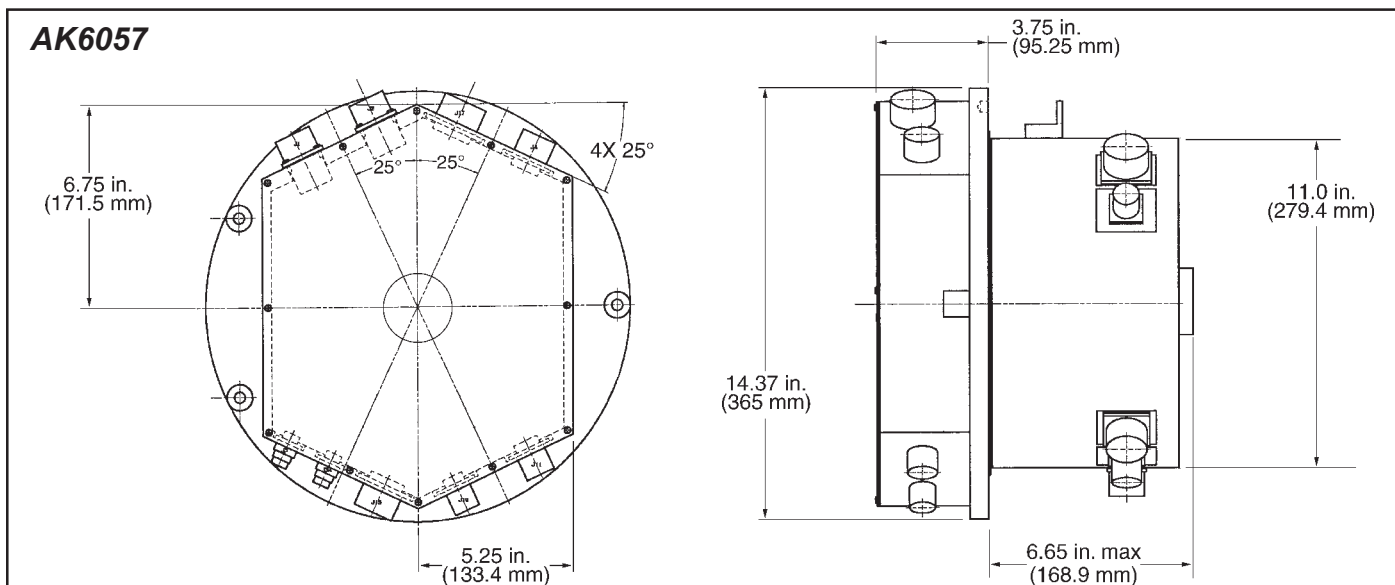
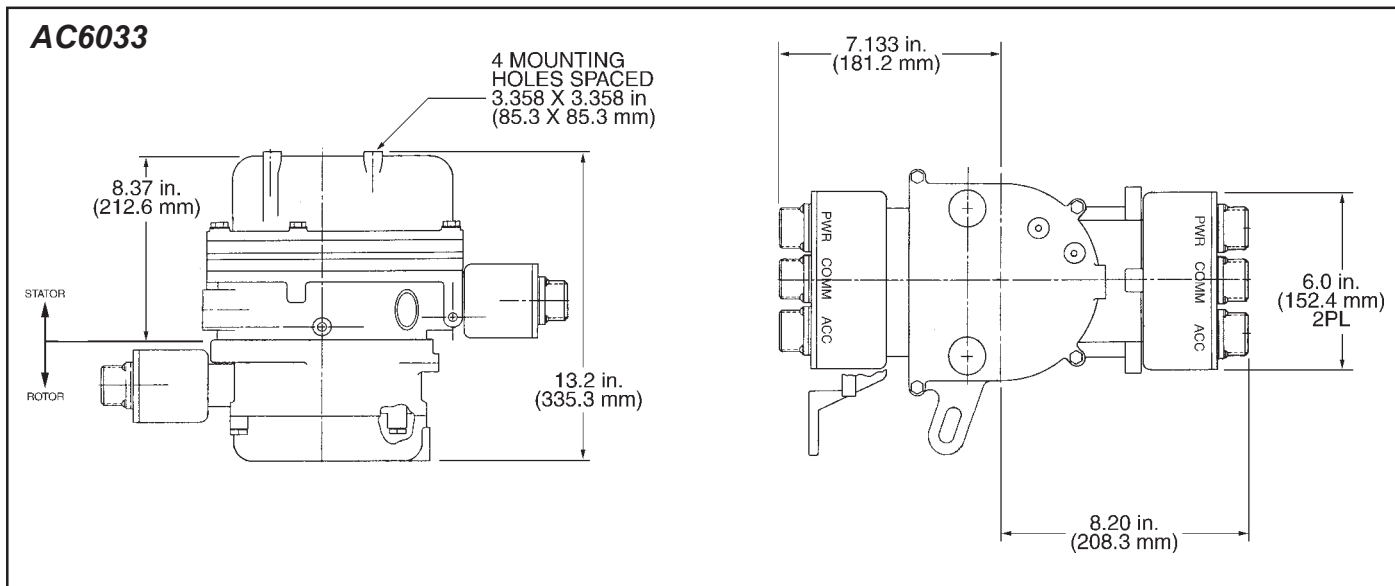
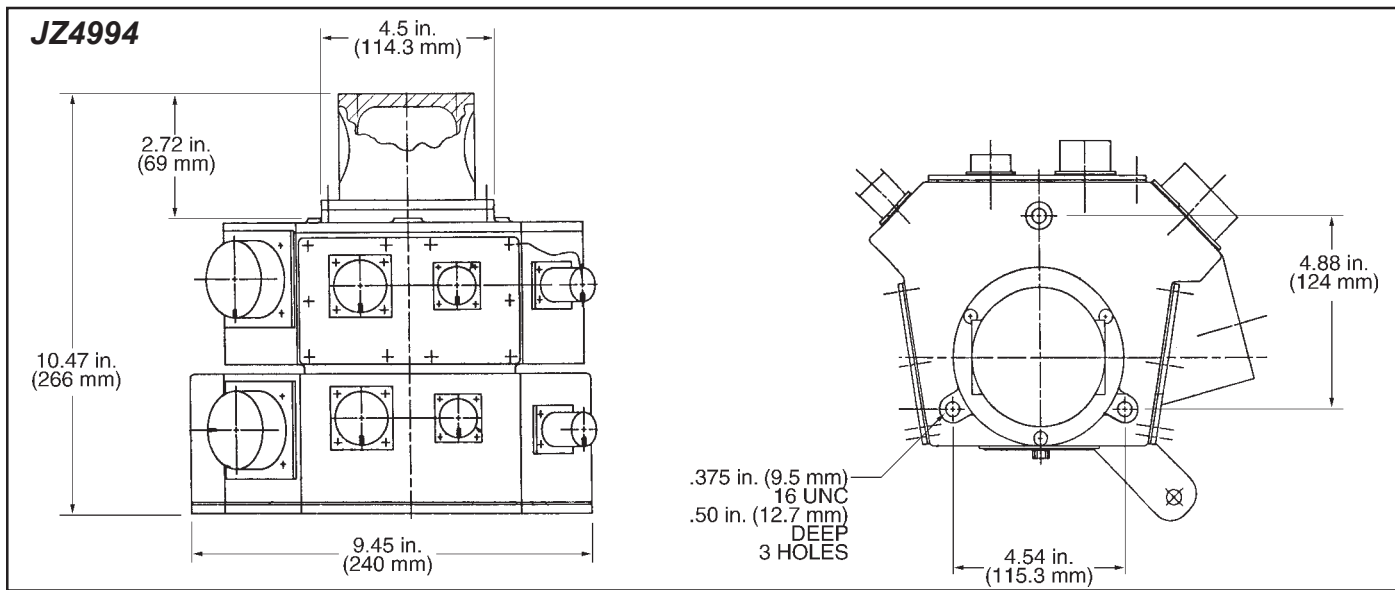


## Typical Vehicular Slip Ring Designs



# Vehicular Slip Rings

## Typical Vehicular Slip Ring Designs



## Helicopter Slip Rings

*Proven reliability in the most demanding of applications and environments*

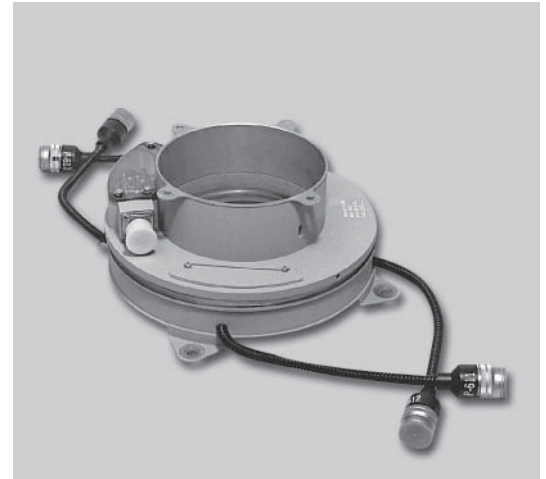
### Description

Today's rotorcraft applications place unique demands on slip ring technology because of equipment requirements and environmental conditions. From de-ice applications (with their need for high rotational speed, exposure to weather conditions and high vibration) to weapon stations and electro-optic sensor systems (with high bandwidth signal transmission), helicopter slip rings must perform in a highly reliable mode with the latest product advancements.

Our many years of experience in this arena has allowed Moog Components Group to be a leader in slip ring technology for rotorcraft applications. Employing a combination of precious metal fiber and composite brush technology for signal and power transfer, we are qualified to meet the most demanding applications effectively and economically. Contact us with your requirements so we can help you find a solution.

### Features

- Multiple contact technologies suited for the application
  - Monofilament wire brush
  - Multiple precious metal fiber brush
  - Composite brush
- Environmental sealing
- EMI Shielding
- FEA structure analysis
- High shock and vibration capabilities
- Wide operating temperature envelope
- Vertical integration of position sensors & ancillary products
- High frequency bandwidth
- High reliability and life
- Redundant bearing designs



### Typical Applications

- Blade de-ice
- Blade position
- Tip lights
- Flight controls
- FLIR Systems
- Target Acquisition Systems
- Weapon stations

# Helicopter Slip Rings

Electrical slip rings are used in helicopter, tiltrotor and rotorcraft applications for a variety of applications. Historically, slip rings were initially intended for use in blade de-ice and tip-light applications where electrical power was required for the main and tail rotor blades. Today, with the advent of tiltrotor aircraft, slip rings are transmitting flight control and blade position data. Reliability and data integrity has never been more important.

Advanced aircraft now carry infrared and electro-optic sensors, target acquisition systems and weapon stations requiring unrestrained rotation. As a result, slip rings (and our related motion technology components) play a much broader and important role.

In addition to producing compact, light weight and highly reliable slip rings, we have provided units that combine conventional electrical slip rings with resolvers, encoders, fiber optic rotary joints other commodities.

## Design

Moog Components Group can offer the most valuable design assistance by being involved early in the development of the aircraft and related subsystems. The internal design of the slip ring capsule will be driven by the circuit requirements, need for ancillary products and the space available for mounting the slip ring capsule. From our

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 for another device or bearing structure
- Connectors – case mounted or attached to cables
- Mechanical support – on either side of the rotating interface including the stand pipe

## Power Circuits

Theoretically, there is no limit to the amount of power that can be transferred by the slip ring assembly. Most rotorcraft de-ice slip rings carry less than 100 amperes of current. It is important that the power duty cycle be defined as early as possible in the design stage. Thermal design requirements can affect other design parameters. If the space available for the slip ring capsule is limited, it may be advantageous to transfer the power at higher voltages. Power can be grounded either through the case of the slip ring or insulated from the case.

## Signal Circuits

Signal requirements for rotorcraft slip ring capsule continue to be increasingly demanding, particularly with the advent of

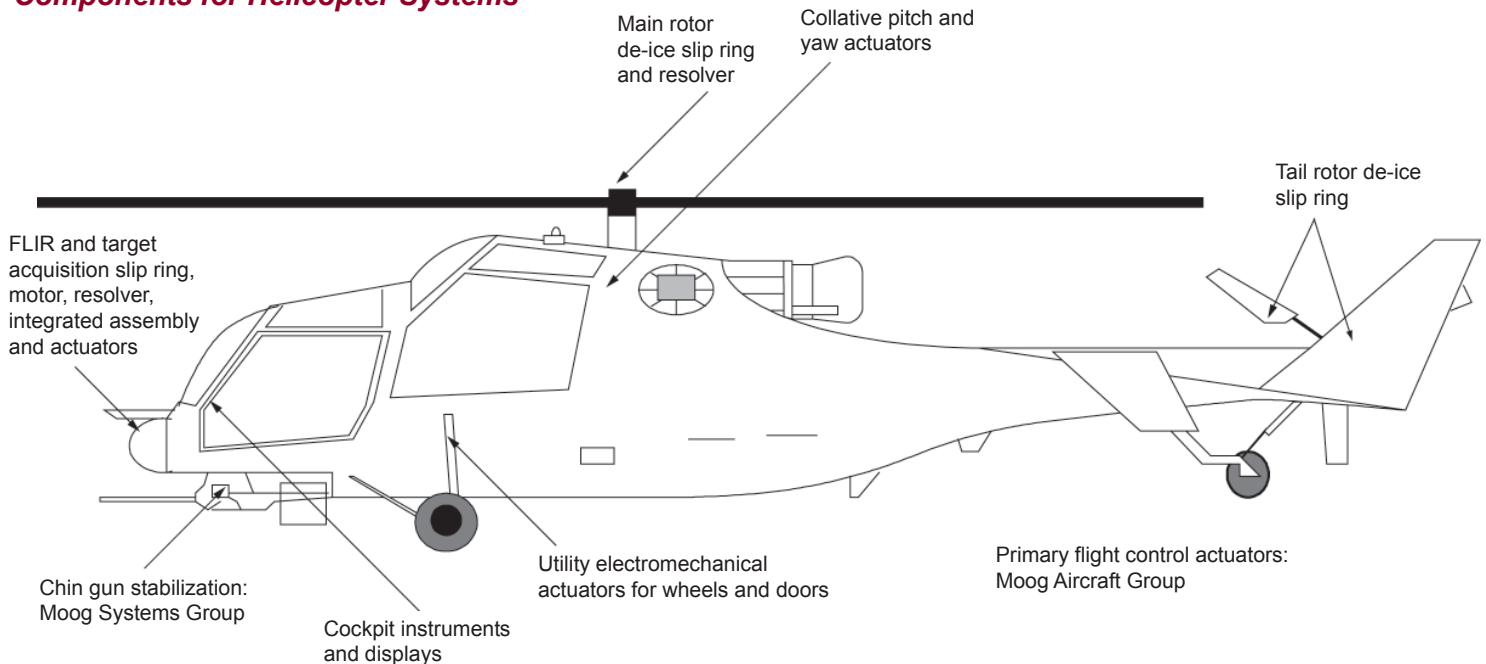
tiltrotor aircraft, electro-optics and target acquisition systems. The circuit functions and electrical isolation requirements have a significant impact on the design of the slip ring. While a de-ice systems has few signal requirements, tiltrotor aircraft require flight control circuitry and electro-optic sensors often require high-bandwidth video, analog and digital control circuitry.

It is often important that sensitive circuits have additional isolation from other circuits and impedance matching for high bandwidth. Such requirements can be much better addressed early in the design stages.

## Slip Ring Experience

Rotorcraft applications pose a variety of design challenges. High vibration, harsh environments and high reliability demands products from a proven supplier. Moog Components Group has a long history of supplying slip ring and motion technology (motors, resolvers, fiber optic and subsystem) products to the rotorcraft industry. Current fielded systems include Apache, Blackhawk, Seahawk, EH-101, S-92, V-22, CV-22 and BA-609 to name a few. Let us put our experience to work for your next rotorcraft application.

## Components for Helicopter Systems



## Poly-Twist™ Twist Capsules

*Limited Rotation Interconnecting Device –  
A Highly Reliable Slip Ring Substitute for Limited  
Rotation Applications*

*Number of circuits limited only to space  
availability*

### Description

Moog Components Group is a leading designer and manufacturer of slip rings, devices that can be used in any electromechanical system that requires unrestrained rotation while transferring power and / or data. However, some applications require only limited rotation.

To fill the need for limited rotation applications, we introduced Poly-Twist™ Twist Capsules, a reliable slip ring substitute that provides up to 1-1/2 turns of rotational freedom. For over 50 years, we've designed and manufactured thousands of units - from miniature to very large assemblies - for a variety of applications.

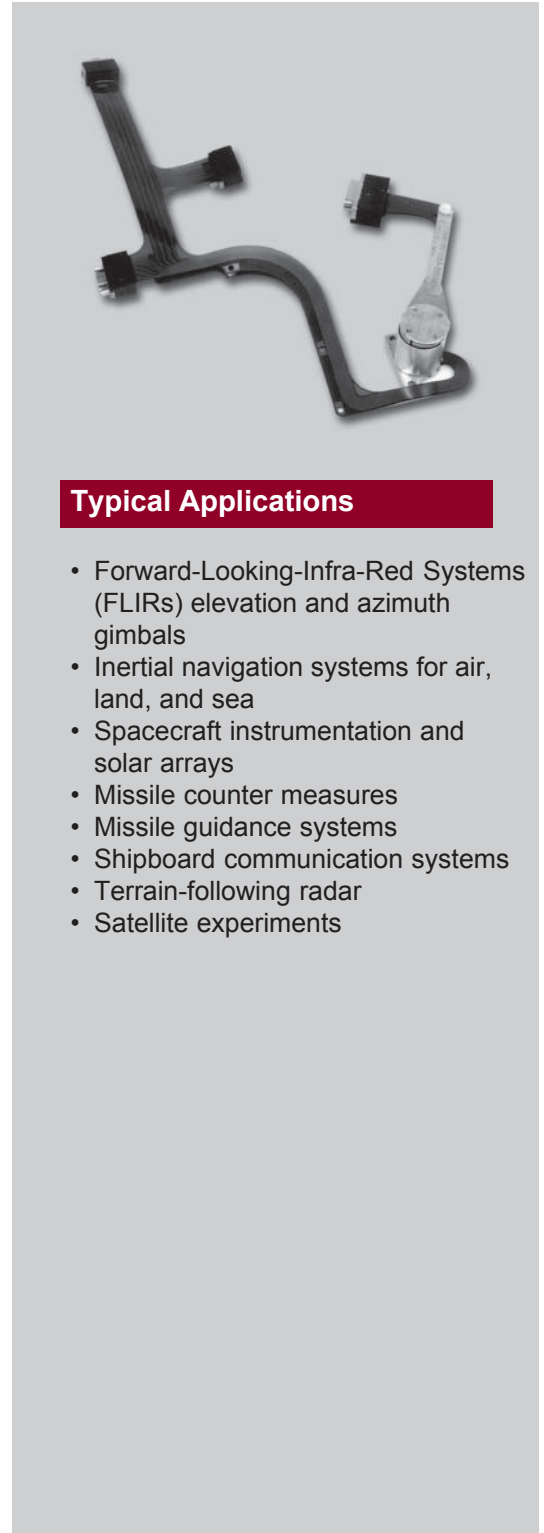
### Features

- Eliminates sliding contacts and associated electrical noise
- Bearingless units available
- No shearing, pulling, sliding or abrading occurs during operation - flexible tapes provide connections between oscillating and stationary circuits
- Provides rotational freedom - up to 1-1/2 turns in each direction from center line
- Low and consistent torque
- Long performance - life often measured in the millions of cycles
- Low outgassing
- High reliability for space/vacuum applications
- Can save weight and increase reliability by replacing flexible cables and harnesses that wear and break
- High frequency and power circuits available
- Multiple methods available for termination of electrical interfaces
- Mechanical stops for over-travel protection
- Existing designs can be modified to meet custom requirements

### Integration Capabilities

- Coax cable
- Resolvers
- Fiber optic channels
- RF joints
- Motors
- Hydraulic / pneumatic (fluid) joints
- Servo actuators

- Export of the items in this brochure is regulated by the U.S. Department of State. Buyer shall comply with these regulations.



### Typical Applications

- Forward-Looking-Infra-Red Systems (FLIRs) elevation and azimuth gimbals
- Inertial navigation systems for air, land, and sea
- Spacecraft instrumentation and solar arrays
- Missile counter measures
- Missile guidance systems
- Shipboard communication systems
- Terrain-following radar
- Satellite experiments

# Poly-Twist™ or Twist Capsules

## GENERAL CONSIDERATIONS FOR POLY-TWIST™ CAPSULES

### How They Work

Poly-Twists resemble slip ring assemblies in size and appearance and provide multiple turns of rotational freedom. They utilize a flexible circuit tape for those applications where continuous rotation is not required.

Poly-Twists operate by winding and unwinding flexible circuit tapes wrapped around a central shaft in a configuration resembling a clock spring. The central shaft is generally suspended on ball bearings. One end of each tape is fastened to the shaft, with lead wires extending from the shaft either axially or radially. The other end of the tape is fastened to the Poly-Twist frame, which is usually considered stationary. Stator lead wire terminations may also be either axial or radial.

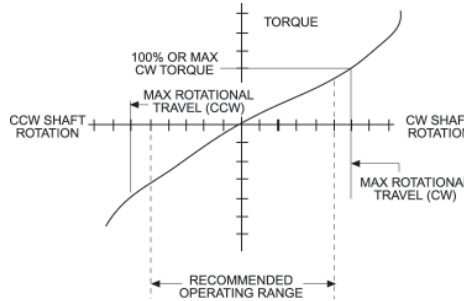
Electrical noise is eliminated because there are no sliding contacts - flexible tapes provide the connection between the rotating and stationary circuits. The tapes provide constant circuit resistance which is not degraded by wear, shock or vibration during the life of the Poly-Twist - often measured in millions of cycles. Many existing designs are available or we can custom design a Poly-Twist to meet your specific requirement.

### Torque

The key to low torque and long life in Poly-Twist capsules is the flexing element. No shearing, pulling, sliding or abrading occurs during oscillation of the unit. Consequently, the endurance limit is well beyond what can be achieved with flexible cabling and wire bundles.

Torque is reduced. Size is minimal. Handling and mounting are simplified. Flexible cables or harnesses presently being used can be replaced, eliminating fatigue wear.

The characteristically low shaft torque varies with the number, size and configuration of the flexible circuit tapes. The typical torque vs. travel curve is approximately linear over the operating range of the Poly-Twist as indicated in the diagram below. The maximum torque occurs at maximum angular excursion. Poly-Twist designs using symmetrical circuit tapes will have similar torque values in each direction.



### Mounting

A brief view of the drawings that follow will illustrate some of the typical Poly-Twist mounting provisions available in standard units. Poly-Twist units should be installed with one member floating and one member hard mounted, similar to the mounting of miniature slip ring capsules. The floating member may be driven by a drive key, pin, or by the leads. This method of mounting prevents overloading of the capsule bearings due to improper shaft alignment.

Poly-Twist devices may be supplied without bearings if the customer desires to mount the Poly-Twist directly to an existing shaft or rotating assembly. The Poly-Twist may also be designed with a center line through-bore to meet special application requirements.

Our engineers will be pleased to discuss Poly-Twist designs to meet your specifications.

CONVERSION TABLE		
FROM	TO	MULTIPLY BY
<b>Length</b>		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281x10 <sup>-2</sup>
<b>Mass</b>		
oz	g	28.35
lb	g	453.6
g	oz	3.527x10 <sup>-2</sup>
lb	oz	16.0
g	lb	2.205x10 <sup>-3</sup>
oz/lb		6.250x10 <sup>-2</sup>
<b>Torque</b>		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383x10 <sup>4</sup>
g-cm	oz-in	1.389x10 <sup>-2</sup>
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233x10 <sup>-5</sup>
oz-in	lb-ft	5.208x10 <sup>-3</sup>
<b>Rotation</b>		
rpm	degrees/sec	6.0
rad/sec	degrees/sec	57.30
degrees/sec	rpm	.1667
rad/sec	rpm	9.549
degrees/sec	rad/sec	1.745x10 <sup>-2</sup>
rpm	rad/sec	.1047
<b>Moment Of Inertia</b>		
oz-in <sup>2</sup>	g-cm <sup>2</sup>	182.9
lb-ft <sup>2</sup>	g-cm <sup>2</sup>	4.214x10 <sup>5</sup>
g-cm <sup>2</sup>	oz-in <sup>2</sup>	5.467x10 <sup>-3</sup>
lb-ft <sup>2</sup>	oz-in <sup>2</sup>	2.304x10 <sup>3</sup>
g-cm <sup>2</sup>	lb-ft <sup>2</sup>	2.373x10 <sup>-6</sup>
oz-in <sup>2</sup>	lb-ft <sup>2</sup>	4.340x10 <sup>-4</sup>
oz-in-sec <sup>2</sup>	g-cm <sup>2</sup>	7.062x10 <sup>4</sup>

## A Life Test Summary of Typical Poly-Twist™ Capsules

Part Number	Serial Number	Number of Circuits	Degrees of Travel	Cycle Rate	Cycles without Failure
BB4271	58	34	±180° (360° Total)	60 per min	16,761,600*
DT4096	1-T	20	±40° (80° Total)	4 per min	10,500,000*
DT4097	1-T	20	±40° (80° Total)	4 per min	19,500,000*

\*Exceeded life requirements test terminated.

**Note:** The actual results may vary, depending upon the specific application.

# Poly-Twist™ or Twist Capsules

## TECHNOLOGY COMPARISONS AND TYPICAL SPECIFICATIONS

### A Comparison: Cable Wrap vs. Poly-Twist™ Twist Capsule vs. Slip Ring

**Note:** A rating of 1 is most desirable.

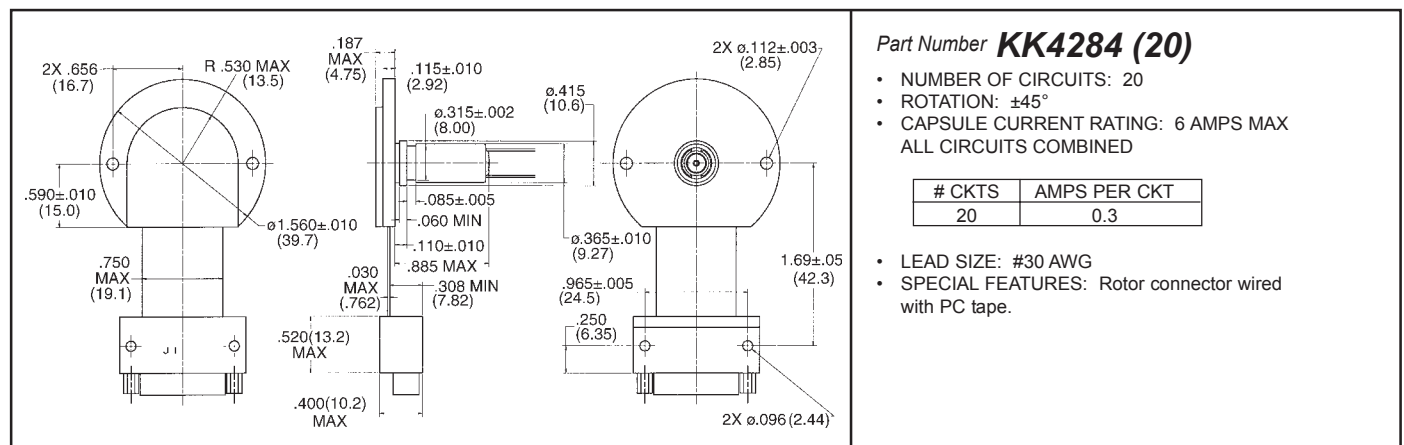
Property	Cable Wrap	Poly-Twist™ Twist Capsule	Slip Ring	Comments
Life Expectancy	3	1	2	
Signal Quality Over Life	2 or 1	2 or 1	3	
Torque	3	1	2	
Linearity of Torque	3	1	2	
Stability	3	1	2	Unpredictable, cables flop around
Cost:				
Large Diameter (D / L > 1); 125 ckts	1	2	3	
Small Diameter (D / L < 1); 125 ckts	1	3	2	
Circuit Density:				
(D / L > 1)	3	1	2	
(D / L < 1)	3	1	1	Slip ring and twist capsule about equal
Voltage Drop	2 or 1	3	1 or 2	Depends on cable wrap service loop length required to accommodate travel
Crosstalk	1	3	2	*If space sufficient, coax can be used internal to twist capsule
Controlled Impedance	1	3	2	*If space sufficient, coax can be used internal to twist capsule
Insulation Resistance:				
Dry	1	3	2	
Humid	1	2	3	Slip ring most affected by humidity
Total Rotational Travel	3	2	1	Cable wraps have very poor bend radius

### Specifications for typical Poly-Twist designs

This information lists some of our typical designs with various ranges in the number of circuits. These parts are only a few of our designs.

So that we can better serve you, please call us and talk to one of our design engineers about your application. Perhaps one of our other standard designs, not shown in this application guide, would fit your application better, or we can design one to meet your specific requirements\*.

\*Tooling and engineering charges may apply.

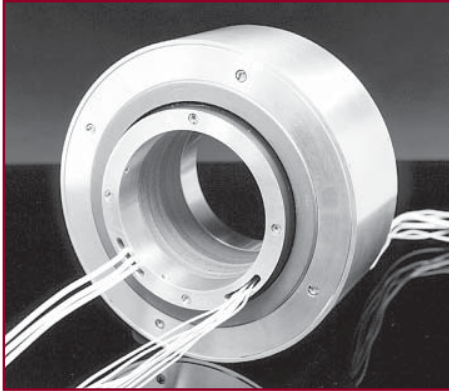


Dimensions are in inches (millimeters)





## Do Slip Rings Fit in the Digital World?



### Introduction

As the analog world gives way to the digital in more and more applications, design engineers are faced with replacing traditional analog components with their digital equivalents. Nowhere is this more evident than in the electro-mechanical world. Analog resolvers are being replaced by digital encoders and digital drive circuitry has become commonplace for motor control. When part of the system has to rotate, and a rotary connection for power and digital data is required, what does the designer do? Can the traditional slip ring with its sliding electrical contacts handle the job?

### The Problem

Slip rings were originally designed to carry AC and DC power from a rotating platform to a stationary structure, or vice versa. Many applications also required, and still require, the transmission of relatively low bandwidth analog and digital control signals. In this environment, the traditional slip ring performs extremely well. Modern control systems now also require the transmission of high bandwidth analog and digital signals through the slip rings. Typical examples are analog and digital video signals. Until recently, bandwidths measured in the tens of megahertz were generally adequate. Today, and in the future, bandwidths will be required that are orders of magnitudes higher.

### Basic Slip Ring Configuration

A basic slip ring, shown schematically in Figure 1, is composed of four elements, or components.

- A ring assembly that provides one or more circuit paths. Each ring is electrically conductive and provides a circuit path over a full 360 degrees of rotation of the ring assembly.
- Brushes provide electrical contact between the rotating (usually the ring) and the stationary parts of the assembly. The brushes ride on the ring, and are mounted in a brush block assembly, usually on the stationary structure.
- Input and output leads that connect the ring and brushes to the outside world.
- Connectors that connect to the slip ring assembly wiring. Connectors are optional, and are often specified by the customer.

### Factors Affecting Slip Ring Performance

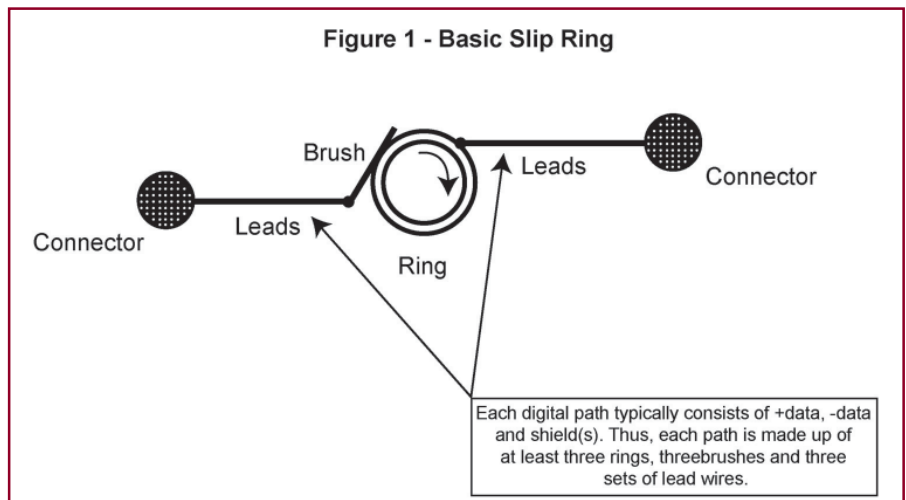
The following factors will determine the data rate that can be transmitted through a slip ring:

- The frequency response, or insertion loss, of the rings and brushes.
- The impedance, as a function of frequency, of the assembly.
- The differential time delay, as a function of frequency, through the device.

- Crosstalk between circuits.
- Frequency response of the leads and connectors.

The primary factor is frequency response, or bandwidth. Digital data streams will begin to suffer errors from insufficient bandwidth when the digital signal is attenuated, or distorted, to such an extent that the digital receivers cannot properly recognize the received signal. A digital signal is composed of a fundamental frequency at the basic signaling rate, as well as the odd harmonics of the fundamental. The required bandwidth of the slip ring may be several times the data rate.

For example, a 1 MHz square wave may require a bandwidth of 5 or 7 MHz (5th and 7th harmonics). As the data rate is increased, eventually the harmonics is matched to the external system input and output impedances. Using transmission line theory, the designer will vary ring geometry, spacing, and dielectric material, to obtain the needed impedance. Often a ring and brush impedance of 70 to 150 ohms is obtainable, which should be well suited for many of today's digital systems. As a rule of thumb, a smaller diameter ring will result in a higher data rate. For very high data rates and/or large ring diameters, multiple taps and multiple brushes are often used to minimize signal path lengths.



# Technical Information

For optimal performance, high frequency digital signals should be driven differentially, and connected to the slip ring using twisted pair, shielded cable such as CAT5 or CAT5e. This same wiring, including the shield, should be continued through the slip ring. Ideally, the internal slip ring wiring would also be twisted pair shielded cable, however, this may not always be possible due to physical constraints. Connectors, if used, must also be designed, or chosen, to have an impedance and frequency response consistent with system requirements.

Crosstalk between sensitive circuits will also be minimized by proper lead routing and shielding. Sensitive circuits (victims) should be routed within the slip ring as far away from noisy circuits (sources) as possible. Also, all unused circuits should be terminated in the characteristic impedance of the cables used.

## Slip Ring Fundamentals

*A standard slip ring has four elements, or components:*

- A **ring assembly** provides one or more circuit paths. Each ring is electrically conductive and provides a circuit path over a full 360° of rotation of the ring assembly.
- **Brushes** provide electrical contact between the rotating (usually the ring) and the stationary parts of the assembly. The brushes ride on the ring, and are mounted in a brush block assembly, usually on the stationary structure.
- Input and output **leads** connect the ring and brushes to the outside world.
- **Connectors** link to the slip ring assembly wiring. They are optional and often specified by the customer.

## Specifying a High Performance Slip Ring

This article has attempted to make users aware of factors that determine slip ring performance, and of the limitations imposed by the total system in which the slip ring must operate. It is no longer adequate to simply request a device "that will transmit 50 mbs." The best solution is obtained when the entire system is known and understood, and usually requires a compromise between performance, size, weight, number of circuits, external factors, and cost.

The following parameters should be specified to assure satisfactory operation in a specific application:

- Data bus used to transmit data, i.e. Profibus, Ethernet, Firewire
- Cable type used to connect to the slip ring
- Maximum cable length between transmitter and receiver
- Maximum data rate
- Maximum error rate that can be tolerated
- Maximum size, i.e. diameter and length
- Number of circuits and their ratings, i.e. voltage, current
- Maximum operating speed of rotation
- Operating environment

Moog Components Group has thousands of slip ring designs, including many standard "off the shelf" designs. Our engineering staff is available to modify an existing design or to provide a complete new design, if required. However, customers are encouraged to evaluate a standard design before requesting modifications that may not be needed.

We have tested many of our standard designs for high data rate performance. Devices with through bores of up to six inches have been tested. Testing has included insertion loss, frequency response, bit error rates, differential time delay, and impedance over frequency. In some cases we have identified, and implemented, design modifications to significantly improve performance. As a

general statement, all devices that have been tested will support digital data rates of at least 50 mbs. This verifies that our standard units will operate successfully in a wide variety of standard data systems in use world-wide. These include, but are not limited to: Device Net, CAN Open, Profibus, and Ethernet 10Base T. Additionally, several models tested are suitable for Ethernet 100Base T, and Firewire at 400 mbs.

For the most demanding applications, we have integrated single channel and multiple channel fiber optic rotary joints (FORJs) into our standard slip ring assemblies. The FORJ is used to carry the very high data rate signals, or those circuits requiring very low cross talk or high noise immunity, while conventional slip ring technology is used for transmitting power and other control signals. We can also provide the hardware to perform the electrical- to optical- back to electrical conversion.

## Applications

### **Industrial and Commercial**

- Semiconductor equipment
- Industrial machinery
- Robotics
- Medical equipment
- Packaging machines
- Cable reels
- Laboratory equipment
- CCTV camera mounts
- Lighting
- Rotary index tables
- Rate tables
- Medical CT scanners
- Amusement rides
- Flight simulation

### **Aerospace and Military**

- Inertial navigation systems
- Missile weapon systems
- Satellite assemblies
- Unmanned aerial vehicles
- Airborne camera platforms
- Shipboard communication systems
- Radar
- Tanks
- Light armored vehicles
- Helicopters
- Aircraft

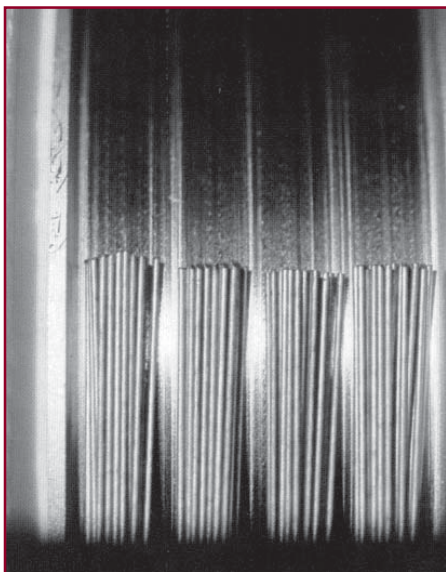
# Fiber Brush Slip Ring Technology

Moog Components Group fiber brush contact technology was initially developed to solve a critical problem in military/aerospace applications. With many years of successful performance in highly critical slip ring applications, the fiber brush technology is available in commercial products as well.

## Fiber Brush Technology For Commercial/Industrial Applications

For many years the traditional design for rotary contact slip rings used either a lubricated monofilament brush or a self-lubricating composite brush. While these traditional approaches have proven to be successful through testing and field experience, improved performance is always desirable. To that end, we developed the fiber brush technology. A chart comparing the advantages of different contact technologies is shown on page 84.

Today's industrial / commercial equipment slip ring requirements are becoming more and more demanding. High operational speeds, long life, no maintenance, and data transfer capability, are the general expectations in slip ring performance. Taking advantage of the developments done in our Advanced Materials Research and Development Department, we have transferred the fiber brush technology to cost effective commercially available



products to address today's critical applications.

Military/aerospace applications require slip rings that provide minimal debris generation, low electrical noise, both high and low current transmission capabilities, low outgassing and a long operational life. They must also operate flawlessly in a wide operating temperature range, and at a variety of brush/ring surface speeds, as well as in air or vacuum conditions.

## Fiber Brush Contact Technology

Fiber brush is the term for a particular design of sliding electrical contacts. Fiber brushes are simply a group of individual metal fibers (wires) that are collimated by and terminated into a metal tube as illustrated in the photo on the left. In this cantilevered design, the free, unterminated end of the fiber brush bundle rides in a groove on the ring surface.

## Many Advantages

Fiber brushes have many distinct and measurable advantages over conventional slip ring contacts in military/aerospace applications:

- Multiple points of ring contact per brush bundle
- Ability to perform in ambient conditions as well as in vacuum conditions
- Contact surfaces that do not require lubrication
- Long life
- Low contact force per fiber
- Low contact wear rates
- High power circuit density
- Low dynamic contact resistance (noise)
- High and low current carrying abilities
- Low outgassing
- Very little debris generation
- Wide operating temperature range
- Wide range of brush/ring surface speeds

## Proven Performance

As an alternative to traditional sliding contact designs, Moog Components Group fiber brush was developed to meet the increasing demands of slip ring performance. The technology has been used in many demanding applications such as:

- CT Scan systems
- High speed testing
- Robotic welding systems
- High-speed, in-line inspection systems
- Radar platforms

## A Growing History

Moog Components Group started in 1953 as a supplier of high reliability slip rings to the military and aerospace community. Over the years we have developed a reputation as a quality and precision supplier for space, weapons, aircraft and other mission critical program requirements. It is this stringent quality and technology that has now carried over to our commercial products group. We have adapted technology designed and produced for defense applications for use in our growing line of standard commercial products.

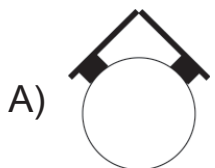
All of our experience and expertise helps our customers in a very real measurable fashion. We make a point to fully understand our customers' applications and by teaming with our customers we are able to efficiently coordinate their needs with our engineering and production departments. We have for years had a Commercial Slip Ring Team that provides focus allowing us to slash lead times and develop special designs fast and accurately.

## Technology Comparison

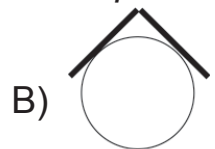
Generally, aerospace slip rings and brushes (sliding electrical contacts) are designed using traditional contact technologies such as lubricated monofilament wire brushes or self-lubricated composite brushes. These approaches have been proven successful many times through testing and actual flight experience. There are, however, some disadvantages to these approaches.

# Fiber Brush Slip Ring Technology

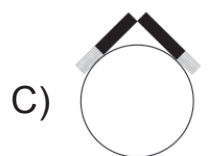
## Types Of Brushes



*Composite*



*Monofilament*



*Fiber*

### Composite Brushes

Unlike monofilament brushes, composite brushes provide their own lubrication through the addition of an embedded solid lubricant to the composition of the brush. The nature of this lubrication mechanism requires that the brush must experience wear to transfer the lubricant from the brush to the ring. This wear results in some amount of electrically conductive debris being generated within the slip ring. While small amounts of this debris can generally be tolerated if proper design procedures are followed, the extended life requirements of new aerospace slip rings could result in the generation of intolerable amounts of this conductive debris.

Also, the contact materials used in composite brush slip ring designs can be contaminated by absorption of airborne gasses. The principal form of

this contamination is silver sulfide, which appears as tarnish. When exposed to temperatures of less than 178° C, these films have semiconducting properties (increase in electrical conductivity with increased temperature). The presence of silver sulfide films at low temperatures may cause unacceptably high contact resistance on low current circuits.<sup>1</sup> On the following page is a chart that summarizes the characteristics of the different types of contact technologies.

### Monofilament Brushes

Aerospace rated monofilament brushes depend on intentional lubrication of the contact surfaces to perform properly. Many of the liquid lubricants used will not meet NASA outgassing requirements, and the ones that do typically have poor viscosity characteristics at low temperatures. Designs using this contact technology must be analyzed to ensure

## Comparison of sliding electrical contacts for space applications.

<b>Composite Brushes</b> Ag/MoS <sub>2</sub> /Graphite	<b>Monofilament Brushes</b> Lubricated	<b>Fiber Brushes</b> Unlubricated
Most flight history	Considerable flight history	Growing flight history
Meets outgassing requirements	Does not meet outgassing requirements	Meets outgassing requirements
Self lubricating contacts (solid lubricant in brushes)	Requires liquid lubricant on contact surface	No oil or dry film lubricant application required
Requires largest ring-to-ring axial pitch	Requires smallest axial pitch (50% of composite brush pitch)	Requires less axial pitch than composites (70% of composite brush pitch)
Manufacture subject to greatest number of process variables	Manufacture subject to few process variables	Manufacture subject to few process variables
Greatest amount of wear debris generation (approximately 100 times the wear rate of fiber or monofilament brushes)	Much smaller amount of wear debris generation than composite brushes	Smaller amount of wear debris generation than composite and monofilament brushes
High electrical noise if operated in humid environment	Low electrical noise in air and vacuum	Low electrical noise in air and vacuum
Must operate in vacuum or dry inert atmosphere	Operational in air or vacuum with lubricant present	Operational in air or vacuum
Wide operating temperature range	Viscosity limited operating temperature range	Wide operating temperature range
Wide range of surface speeds	Limited range of surface speeds	Wide range of surface speeds

# Fiber Brush Slip Ring Technology

that sufficient lubrication is maintained throughout the system life requirements.

## Materials Choices

One of the most important features of any military or aerospace design is the choice of component materials. Materials must be carefully chosen to reduce outgassing, control dissimilar thermal expansions, reduce galvanic corrosion, and provide nuclear hardening, among other concerns. Materials choices for fiber brush slip rings are much the same as used in traditional slip ring designs with the major exception of the contacts. Fiber brush contacts (fiber and ring surfaces) can be manufactured using alloys of copper, gold, silver and palladium. The actual choice of contact materials depends largely on the electrical requirements of the slip ring. Moog Components Group controls all materials and materials suppliers to verify and ensure consistent quality.

## Commercial Fiber Brush Products

Our commercial fiber brush products include a variety of products with power capabilities up to 100 amps and down to low level data transfer, all within the same housed design! Our product family includes:

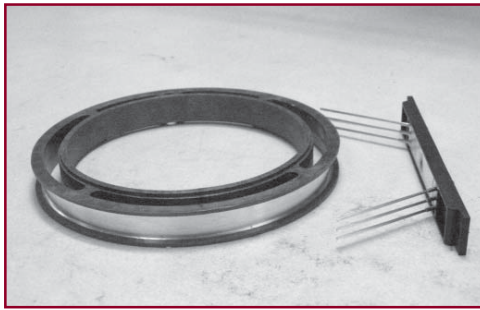
- AC6349, 1" bore
- AC4598, 1.5" bore
- AC6200, 1.5" bore
- AC6275, 2.75" bore
- AC6098, 4" bore
- EC3848, high speed

These products are highly configurable to meet your requirements with readily available products.

## Commercial Separate Products

These products are highly configurable to meet your requirements with readily available products.

In addition to these enclosed slip ring capsules we also provide fiber brush separates. When a "self-contained" capsule is not practical due to system size or cost constraints, fiber brush separates are an excellent alternative.



These separates are available in the following configurations:

Bore Size	Current
1.8"	2 amps
2.8"	5 amps
	10 amps
	30 amps
	50 amps
4.0"	10 amps
	30 amps
	50 amps

Properly mounted and aligned, fiber brush separates provide the same exceptional performance characteristics of our self-contained capsule designs.

## Our Staff

Our staff includes electrical, mechanical, manufacturing and software engineers, metallurgists, chemists, physicists and materials scientists. Our emphasis on research and product development has provided us with the expertise to solve real-life manufacturing problems. Using state-of-the-art tools in our complete analytical facility, our capabilities include a full range of environmental test, calibration and inspection services. We have recognized expertise in tribology (the science of friction and wear), precision gearing, magnetic circuit design, PWM amplifier design and in the supporting materials sciences.

Our engineers can work from your designs, or create a custom design for you.

## Consistent Quality

Moog Components Group places a continuing emphasis on quality manufacturing and product development to ensure that our products meet our customer's requirements as well as our stringent quality goals. We have committed to the Total Quality Management Program with a policy of "Do It Right the First Time" and a goal of "Zero Defects". We are ISO 9001 Certified to ensure the consistent quality and reliable performance of our products.

The newest initiative of our division is Demand Flow® Technology (DFT). DFT is a demand driven manufacturing flow system that economically manages in-process inventory. The concept operates with a "line-of-sight" premise which provides visibility for all in-process work. This concept has helped the division be more efficient and flexible to customer schedule changes, reduced inventories and improved organizational operations. Benefits include streamlined processes to accommodate jobs with a quick turn-around, reduced cycle time to cut costs, and greater customer responsiveness.

<sup>(1)</sup>Roberts E.W., Sliding Electrical Contacts in Space: Observations on Existing Technology and New Trends in Low-Speed Applications, European Space Tribology Laboratory.

Demand Flow® is a registered trademark of the J<sub>c</sub>-I-T Institute of Technology, Inc.





## MOTION TECHNOLOGY

### **Motors**

Moog Components Group provides a complete line of DC motors including brush, brushless and direct drive. These high quality motors are developed for a wide variety of applications, including medical, automation, commercial, aerospace and defense. Optional gearmotors, encoders and tachometers are available. Electronic drives are available for optimum system performance.

### **Slip Rings**

Moog Components Group has over 6,000 slip ring designs that are used in systems that require continuous rotation while transmitting power and data from a stationary unit to a rotating device. In addition, we integrates fiber optic rotary joints into slip ring assemblies for applications that require extremely high data rate signals.

### **Resolvers**

Moog Components Group's line of brushless resolvers are economical and highly accurate motion feedback sensors that are used to provide position and velocity information for closed-loop control, as well as brushless DC motor commutation.

### **Actuators**

Moog Components Group offers high technology and utility electromechanical actuators for aerospace and commercial applications. These actuators utilize brush and brushless DC motors, planetary gears, modulated smart servo amplifiers, PWM amplifiers, multi-speed resolvers and potentiometers.

## FIBER OPTICS

Moog Components Group expands and enhances its motion capabilities with its expertise in fiber optic design and development. From MEMS-based fiber optic switches to large rotary joints to fiber optic modems, we offers an array of solutions for today's demanding applications.

## CUSTOM SOLUTIONS

Moog Components Group does not stop with just standard models. Over the years, we have learned that many projects require a product that has unique specifications - either designed from scratch or modified from another design. One of our strong points is providing exactly the right custom solution.

Specification and information are subject to change without prior notice.  
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**MOOG**  
COMPONENTS GROUP

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