Courtesy of U.S. Army

MOTION CONTROL CATALOG
BRUSHLESS AND BRUSH MOTORS,
ALTERNATORS, RESOLVERS AND
INTEGRATED ASSEMBLIES

MOOG

MOTION TECHNOLOGY CATALOG INDEX

Moog Inc. is a worldwide designer, manufacturer, and integrator of precision control components and systems. Moog's high-performance systems control military and commercial aircraft, satellites and space vehicles, launch vehicles, missiles, automated industrial machinery, marine and medical equipment.

Moog's Power and Data Sector, headquartered in Blacksburg, Virginia, is an innovative provider of power and data transfer solutions, motion control, and electronic products that are designed and manufactured to meet the demanding technical and environmental requirements of the defense and space markets. Moog products can be found on armored vehicles, electro-optic / infrared systems, helicopters, space satellites and other mission critical applications.

More information about Moog is available at **www.moog.com**.

Note: Products listed herein are subject to U.S. Export Regulations and may require export licensing. Contact Moog to obtain specific export control requirements.

DB MATRIX™ SERIES FRAMELESS BRUSHLESS DC TORQUE MOTORS

The DB Matrix™ Series brushless torque motors are used in applications that require high power density and / or quick accelerations. The designs are optimized to minimize input power for maximum efficiency.

Utilizing high energy rare earth magnets and dense slot fills, the DB Matrix Series achieves high Km values. This provides the highest performance per volume and minimizes the motor footprint within the system.

The motors are supplied as a direct drive rotor / stator frameless part set that is directly attached to the load. This form of attachment eliminates backlash and increases servo stiffness for an optimized direct drive system.

The DB Matrix Series is a family of motors consisting of a wide range of sizes, outside diameters from 1.5 to 22 inches (38 to 558.8 mm) with several stack sizes for each diameter.

Along with our standard Matrix motors, our engineers design custom solutions. If our existing models don't meet your needs, we will tailor them or provide options for a best value solution to meet your exact requirements.

FEATURES
- Compact
- Peak torques from 21 - 211 oz-in (.15 - 1.48 Nm)
- Double insulated high temp magnet wire minimizes leakage current and provides good thermal resistance
- Stable high temp encapsulation material minimizes movement or working of windings under large temperature variations
- Rare earth magnets
- High power density
- High torque to inertia ratio
- Low speed with high accuracy
- Large through bores

BENEFITS
- Operate over a wide range of speeds - not limited to AC frequency
- Extremely quiet operation with long life capability
- Motor life is not limited to brush or commutator life
- Efficient operation without losses associate

TYPICAL APPLICATIONS
- Speed and rotation control systems
- Gimbals for FLIR and inertial navigation systems
- Stabilized gun and fire control systems for combat vehicles
- Fire control radars for land and shipboard defense
- Cockpit instrumentation for military and commercial aircraft
- Space and vacuum instruments, actuation systems and momentum wheels

DB MATRIX™ SERIES OVERVIEW

A brushless DC torque motor is a motor which is electronically commutated and exhibits the linear speed torque characteristic of a conventional DC motor. The performance of the brushless DC motor is dependent on the commutation of current in the motor windings, which is controlled by a separate electronic controller. Most controllers require some type of position feedback for proper operation. Common feedback devices are Hall Effect sensors, resolvers and encoders. Moog offers all three types and provides technical assistance in choosing the correct sensor for your application.

Design Considerations

All diameters listed have finished ground lamination surfaces. They can be complemented with rings and hubs for mounting convenience. If you require a housing that may also include bearings, torquer motor, synchro, potentiometer, or similar components, we can design the entire assembly to meet your mechanical dimensions and performance requirements.

Mounting Considerations

Since torque motors are normally delivered in kit form, you provide the mounting surfaces and bearings. When you design the mechanics of the mount, be sure to observe these rules:

1. Eccentricities from the inner member mounting surface should not exceed 0.004 inches for rare earth motor designs.

2. The bore of the mounting surface should be perpendicular to the mounting seat within 0.002 inches for rare earth designs.

Electrical Considerations

For each mechanical configuration shown, different winding designs to modify torque, torque sensitivity, DC resistance, can be supplied by Moog to suit your system requirement. In each case, you have the option of selecting one of the existing designs or specifying a new winding designed to meet your exact requirements. For your specific power source (voltage and current), the mathematical relationships shown below in Table 1 will allow you to calculate a particular performance characteristic (for those listed) at the voltage or power capability of your existing power supply.

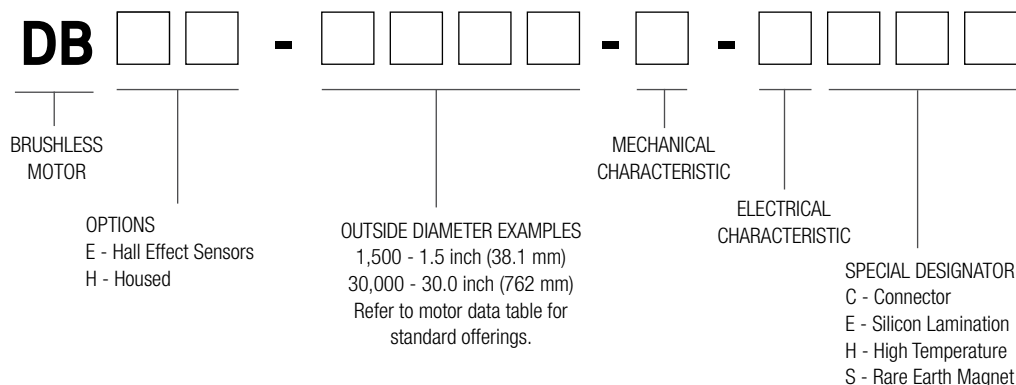| TABLE 1			
Parameter	Symbol	Units	Relationship To Published Parameter
Electrical Time Constant	τ_E	ms	L_M / R_M
Mechanical Time Constant	τ_M	ms	$J_M \bullet R_M$ $K_E \bullet K_T$
Power Input, Stalled At Peak Torque (25°C)	P_P	watts	$V_P \bullet I_P$
Viscous Damping Coefficients Zero Source Impedance Infinite Source Impedance	F_O F_I	oz-in per rad/s oz-in per rad/s	$K_T \bullet K_E$ R_M Small % of F_O
Motor Friction Torque (Actual)	T_F	oz-in	T_F
Maximum Power Rate	P	oz-in / s^2	T_P^2 / J_M
Maximum Theoretical Acceleration	$\propto_M$		T_P / J_M
Theoretical No Load Speed	ω_{NL}		V_P / K_E

[1] T_F is specified as a maximum value and includes brush friction, magnetic detent and test fixture bearing friction which is considered negligible.

[2] In cases where motor is to be operated at some voltage less than V_P due to power supply limitations the new ω_{NL} becomes V_A / K_E where V_A = voltage applied.

OPTIONS

- Winding options to adjust torque sensitivity, back EMF, DC resistance for matching a variety of system requirements
- Varying stack lengths from 0.25 to 2.5 inches (6.35 to 63.5 mm)
- Mounting flanges, hubs, mounting holes and connectors may be added as required
- Hall effect sensors for commutation

PART NUMBERING SYSTEM GUIDE

DB ☐☐ - ☐☐☐☐☐ - ☐ - ☐☐☐☐

BRUSHLESS MOTOR

OPTIONS
E - Hall Effect Sensors
H - Housed

OUTSIDE DIAMETER EXAMPLES
1,500 - 1.5 inch (38.1 mm)
30,000 - 30.0 inch (762 mm)
Refer to motor data table for standard offerings.

MECHANICAL CHARACTERISTIC

ELECTRICAL CHARACTERISTIC

SPECIAL DESIGNATOR
C - Connector
E - Silicon Lamination
H - High Temperature
S - Rare Earth Magnet

Note: The following frame sizes represent only a small sampling of the total range manufactured. Consult factory for additional designs. Refer to our online documentation for product updates.

DB-1500 MATRIX™ SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

| Specification	Units	DB-1500 J-1ES	DB-1500 K-1ES	DB-1500 L-1ES	DB-1500 M-1ES	DB-1500 N-1ES	DB-1500 P-1ES	DB-1500 Q-1ES	DB1500 R-1ES
Peak Torque, T_P	oz-in	21	43	64	85	106	126	170	212
Motor Constant, K_M	oz-in / √W	2.76	4.85	6.51	8.18	9.47	10.56	12.82	14.66
Number of Poles		8	8	8	8	8	8	8	8
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	2.7	4.0	5.4	6.7	8.0	9.3	12	15
Motor Inertia, J_M	oz-in-s^2	9.08E-05	1.80E-04	2.68E-04	3.58E-04	4.46E-04	5.27E-040.4	7.14E-04	8.91E-04
Friction Torque, T_F	oz-in	0.4	0.8	1.1	1.5	1.9	2.3	3.0	3.8
Electrical Time Constant, T_E	ms	0.28	0.44	0.54	0.63	0.69	0.72	0.78	0.82
Mechanical Time Constant, T_M	ms	1.68	1.09	0.895	0.759	0.703	0.670	0.617	0.589
*Temperature Rise, TPR'	°C / W	13.4	9.8	7.8	6.5	5.6	4.9	3.9	3.3
Sensors		No	No	No	No	No	No	No	No

MOTOR WINDING CONSTANTS

Specification	Units	DB-1500 J-1ES	DB-1500 K-1ES	DB-1500 L-1ES	DB-1500 M-1ES	DB-1500 N-1ES	DB-1500 P-1ES	DB-1500 Q-1ES	DB-1500 R-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	1.43	2.85	4.24	5.66	7.05	8.37	11.3	14.1
Back EMF, K_E	V per rad/s ± 10%	0.010	0.020	0.030	0.040	0.050	0.059	0.080	0.100
Terminal Resistance, R_M	ohms ± 10%	0.268	0.346	0.424	0.479	0.554	0.628	0.777	0.925
Terminal Inductance, L_M	mH ± 30%	0.076	0.15	0.23	0.30	0.38	0.46	0.61	0.76
Voltage, Stalled at Peak Torque, V_P	volts	4.0	5.2	6.4	7.2	8.3	9.4	1.7	13.9
Amps at Peak Torque, I_P	amps	15	15	15	15	15	15	15	15

*TPR as listed on the data sheets, is for an unmounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the unmounted TPR. For air flow, the TPR may be less than 25% the unmounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for more accurate estimate of the motor's TPR.
**Stack lengths from 0.25 to 2.5 inches (6.35 to 63.5 mm). The frame size represented is only a small sampling of the total range manufactured. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

WYE CONNECTED

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994
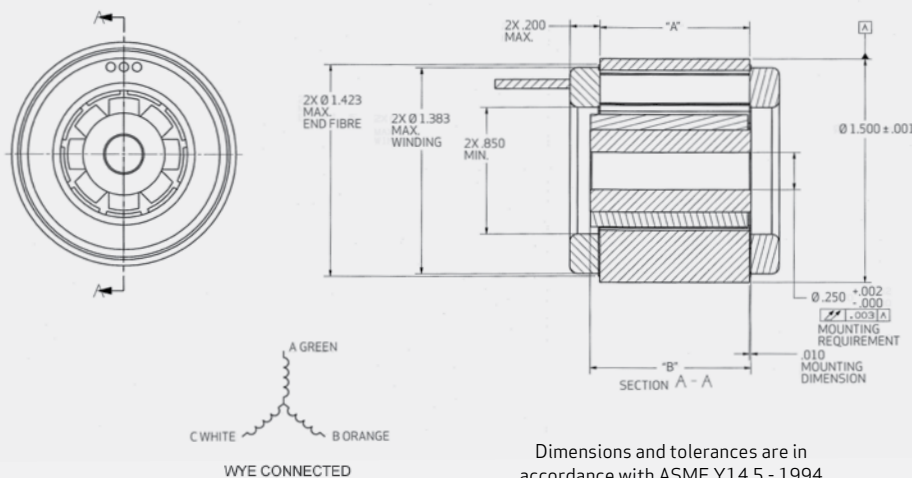
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-1500-J-1ES	0.250	0.310
DB-1500-K-1ES	0.500	0.575
DB-1500-L-1ES	0.750	0.835
DB-1500-M-1ES	1.000	1.100
DB-1500-N-1ES	1.250	1.360
DB-1500-P-1ES	1.500	1.625
DB-1500-Q-1ES	2.00	2.150
DB-1500-R-1ES	2.500	2.675

DB-2000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

| Specification	Units	DB-2000 A-1ES	DB-2000 B-1ES	DB-2000 C-1ES	DB-2000 D-1ES	DB-2000 E-1ES	DB-2000 F-1ES	DB-2000 G-1ES	DB-2000 H-1ES
Peak Torque, T_P	oz-in	34.4	67	99	126	192	256	313	376
Motor Constant, K_M	oz-in / $\sqrt{W}$	4.75	8.18	11.0	12.8	17.1	20.5	23.1	25.7
Number of Poles		8	8	8	8	8	8	8	8
Number of Phases		3	3	3	3	3	3	3	3
Weight	oz (nom)	4.0	6.65	9.2	12	17	22	27	33
Motor Inertia, J_M	oz-in-s^2	2.20E-04	4.41E-04	6.59E-04	8.89E-04	1.32E-03	1.76E-03	2.20E-03	2.64E-03
Friction Torque, T_F	oz-in	1.0	2.0	3.0	4.0	6.0	8.0	10	12
Electrical Time Constant, T_E	ms	0.48	0.74	0.91	1.0	1.2	1.3	1.4	1.4
Mechanical Time Constant, T_M	ms	1.38	0.933	0.777	0.767	0.638	0.591	0.584	0.565
*Temperature Rise, TPR'	°C / W	11.0	8.4	6.8	5.8	4.4	3.6	3.0	2.6
Sensors		No	No	No	No	No	No	No	No

MOTOR WINDING CONSTANTS

Specification	Units	DB-2000 A-1ES	DB-2000 B-1ES	DB-2000 C-1ES	DB-2000 D-1ES	DB-2000 E-1ES	DB-2000 F-1ES	DB-2000 G-1ES	DB2000 H-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	6.89	13.4	19.8	25.2	38.4	51.1	62.7	75.2
Back EMF, K_E	V per rad/s ± 10%	0.0486	0.0947	0.140	0.178	0.271	0.361	0.443	0.531
Terminal Resistance, R_M	ohms ± 10%	2.10	2.68	3.27	3.87	5.04	6.21	7.38	8.55
Terminal Inductance, L_M	mH ± 30%	1.0	2.0	3.0	4.0	6.0	8.0	10	12
Voltage, Stalled at Peak Torque, V_P	volts	10.5	13.4	16.4	19.3	25.2	31.0	36.9	42.8
Amps at Peak Torque, I_P	amps	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

*TPR as listed on the data sheets, is for an unmounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the unmounted TPR. For air flow, the TPR may be less than 25% the unmounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for more accurate estimate of the motor's TPR.

**Stack lengths from 0.10 to 4.00 inches (2.54 to 101.6 mm) with KT to 4.49 N.m/amp. The frame size represented is only a small sampling of the total range manufactured. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994
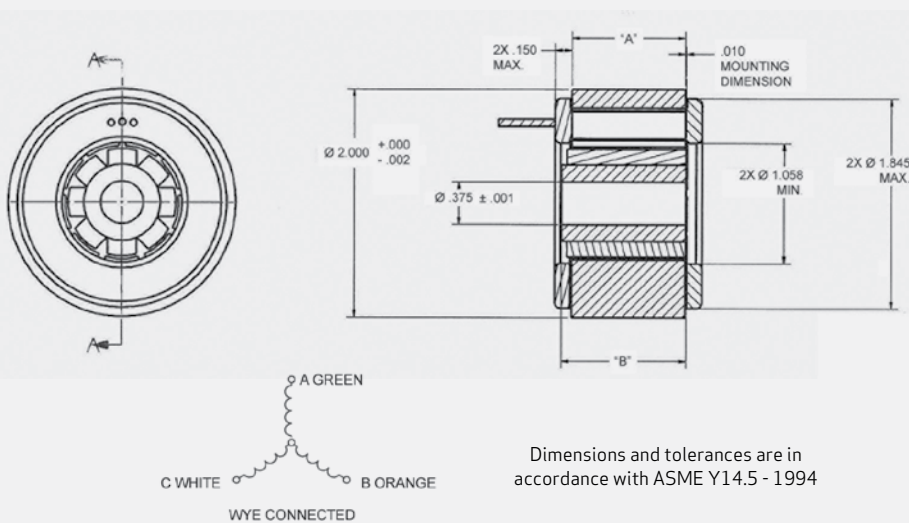
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-2000-A-1ES	.250	.275
DB-2000-B-1ES	.500	.540
DB-2000-C-1ES	.750	.805
DB-2000-D-1ES	1.000	1.065
DB-2000-E-1ES	1.500	1.595
DB-2000-F-1ES	2.000	2.120
DB-2000-G-1ES	2.500	2.650
DB-2000-H-1ES	3.000	3.175

DBE-2000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

| Specification	Units	DBE-2000 A-1ES	DBE-2000 B-1ES	DBE-2000 C-1ES	DBE-2000 D-1ES	DBE-2000 E-1ES	DBE-2000 F-1ES	DBE-2000 G-1ES	DBE-2000 H-1ES
Peak Torque, T_P	oz-in	43	75	100	126	192	256	315	377
Motor Constant, K_M	oz-in / $\sqrt{W}$	5.93	9.16	11.1	12.8	17.1	20.6	23.2	25.8
Number of Poles		8	8	8	8	8	8	8	8
Number of Phases		3	3	3	3	3	3	3	3
Weight	oz (nom)	4.6	7.6	10.1	13	18	23	28	34
Motor Inertia, J_M	oz-in-s^2	4.41E-04	6.59E-04	8.81E-04	1.10E-03	1.54E-03	1.98E-03	2.41E-03	2.85E-03
Friction Torque, T_F	oz-in	1.0	2.0	3.0	4.00	6.0	8.0	10	12
Electrical Time Constant, T_E	ms	0.48	0.74	0.92	1.0	1.2	1.3	1.4	1.4
Mechanical Time Constant, T_M	ms	1.77	1.11	1.02	0.949	0.741	0.660	0.638	0.606
*Temperature Rise, TPR'	°C / W	11.0	8.4	6.8	5.8	4.4	3.6	3.0	2.6
Sensors		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

MOTOR WINDING CONSTANTS

Specification	Units	DBE-2000 A-1ES	DBE-2000 B-1ES	DBE-2000 C-1ES	DBE-2000 D-1ES	DBE-2000 E-1ES	DBE-2000 F-1ES	DBE-2000 G-1ES	DBE-2000 H-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	8.60	15.0	20	25.2	38.5	51.3	62.9	75.5
Back EMF, K_E	V per rad/s ± 10%	0.0607	0.106	0.141	0.178	0.272	0.362	0.444	0.533
Terminal Resistance, R_M	ohms ± 10%	2.10	2.68	3.27	3.87	5.04	6.21	7.38	8.55
Terminal Inductance, L_M	mH ± 30%	1.0	2.0	3.0	4.0	6.0	8.0	10	12
Voltage, Stalled at Peak Torque, V_P	volts	10.5	13.4	16.4	19.3	25.2	31.0	36.9	42.8
Amps at Peak Torque, I_P	amps	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.

**Stack lengths from 0.10 to 4.00 inches (2.54 to 101.6 mm) with K_T to 4.49 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994
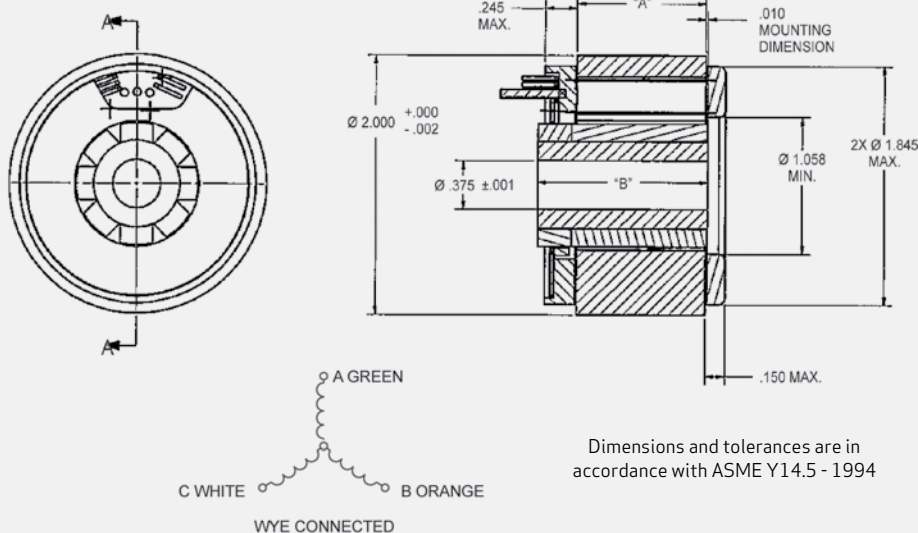
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DBE-2000-A-1ES	0.250	0.540
DBE-2000-B-1ES	0.500	0.805
DBE-2000-C-1ES	0.750	1.065
DBE-2000-D-1ES	1.000	0.330
DBE-2000-E-1ES	1.500	1.860
DBE-2000-F-1ES	2.000	2.385
DBE-2000-G-1ES	2.500	2.915
DBE-2000-H-1ES	3.000	3.440

DB-3000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-3000 F-1ES	DB-3000 G-1ES	DB-3000 H-1ES	DB-3000 J-1ES	DB-3000 K-1ES	DB-3000 L-1ES
Peak Torque, T_P	oz-in	151	302	545	604	909	1214
Motor Constant, K_M	oz-in / $\sqrt{W}$	10.4	18.7	25.8	31.8	42.4	51.3
Number of Poles		12	12	12	12	12	12
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	8.5	15	18	22	31	41
Motor Inertia, J_M	oz-in-s^2	2.11E-03	4.17E-03	6.25E-03	8.32E-03	1.17E-02	1.58E-02
Friction Torque, T_F	oz-in	3.0	5.0	8.0	10	16	20
Electrical Time Constant, T_E	ms	0.7	1.1	1.4	1.6	1.9	2.1
Mechanical Time Constant, T_M	ms	2.75	1.69	1.33	1.16	0.92	0.85
*Temperature Rise, TPR'	°C / W	6.3	5.0	4.1	3.5	2.7	2.2
Sensors		No	No	No	No	No	No

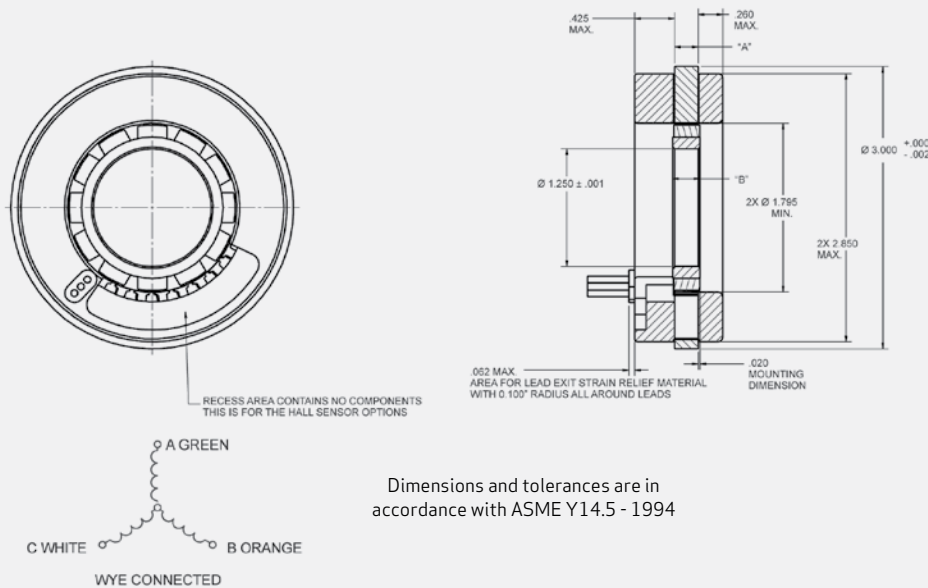## MOTOR WINDING CONSTANTS

Specification	Units	DB-3000 F-1ES	DB-3000 G-1ES	DB-3000 H-1ES	DB-3000 J-1ES	DB-3000 K-1ES	DB-3000 L-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	15.1	30.2	45.4	60.4	90.9	121
Back EMF, K_E	V per rad/s ± 10%	0.107	0.213	0.321	0.427	0.642	0.855
Terminal Resistance, R_M	ohms ± 10%	2.11	2.61	3.10	3.60	4.59	5.59
Terminal Inductance, L_M	mH ± 30%	1.4	2.9	4.3	5.7	8.6	11
Voltage, Stalled at Peak Torque, V_P	volts	21.1	26.1	31.0	36.0	45.9	55.9
Amps at Peak Torque, I_P	amps	10	10	10	10	10	10

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
**Stack lengths from 0.10 to 6.00 inches (2.54 to 125.4 mm) with K_T to 32.5 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

.425 MAX.
.260 MAX.
"A"
Ø 3.000 +.000 -.002
Ø 1.250 ± .001
"B"
2X Ø 1.795 MIN.
2X 2.650 MAX.
.062 MAX. AREA FOR LEAD EXIT STRAIN RELIEF MATERIAL WITH 0.100" RADIUS ALL AROUND LEADS
.020 MOUNTING DIMENSION

RECESS AREA CONTAINS NO COMPONENTS THIS IS FOR THE HALL SENSOR OPTIONS

A GREEN

C WHITE

B ORANGE

WYE CONNECTED

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-3000-F-1ES	.250	.290
DB-3000-G-1ES	.500	.565
DB-3000-H-1ES	.750	.845
DB-3000-J-1ES	1.000	1.120
DB-3000-K-1ES	1.500	1.570
DB-3000-L-1ES	2.00	2.125

DB-4000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-4000 B-1ES	DB-4000 C-1ES	DB-4000 D-1ES	DB-4000 E-1ES
Peak Torque, T_P	oz-in	2000	3000	4000	5000
Motor Constant, K_M	oz-in / $\sqrt{W}$	67.2	91.0	111.5	129.7
Number of Poles		6	6	6	6
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	94.4	136	177.6	217.6
Motor Inertia, J_M	oz-in-s^2	3.65E-02	5.50E-02	7.35E-02	9.20E-02
Friction Torque, T_F	oz-in	10	15	20	25
Electrical Time Constant, T_E	ms	3.27	3.92	4.44	4.76
Mechanical Time Constant, T_M	ms	1.15	0.94	0.84	0.77
*Temperature Rise, TPR'	°C / W	1.6	1.2	1.0	0.8
Sensors		No	No	No	No

MOTOR WINDING CONSTANTS

Specification	Units	DB-4000 B-1ES	DB-4000 C-1ES	DB-4000 D-1ES	DB-4000 E-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	66.5	99.7	132.9	166.1
Back EMF, K_E	V per rad/s ± 10%	0.469	0.704	0.938	1.173
Terminal Resistance, R_M	ohms ± 10%	0.98	1.20	1.42	1.64
Terminal Inductance, L_M	mH ± 30%	3.2	4.7	6.3	7.8
Voltage, Stalled at Peak Torque, V_P	volts	29.5	36.0	42.6	49.4
Amps at Peak Torque, I_P	amps	30.1	30.0	30.0	30.1

Integral Horsepower Design Maximums: 650 VDC, 12,000 RPM, 7% K_T roll off at I_P
*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
**Stack lengths from 0.25 to 8.00 inches (6.35 to 203.2 mm) with K_T to 47.6 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

1.00 MAX.   "A" ±.010   .750 MAX.
.020 MTG. DIM.
2X 3.800 MAX.
2X Ø 2.020 MIN.
Ø .640 ±.001
Ø 4.000 +.000 / -.002
"B"

A BLACK
C WHITE   B RED
WYE CONNECTED

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994
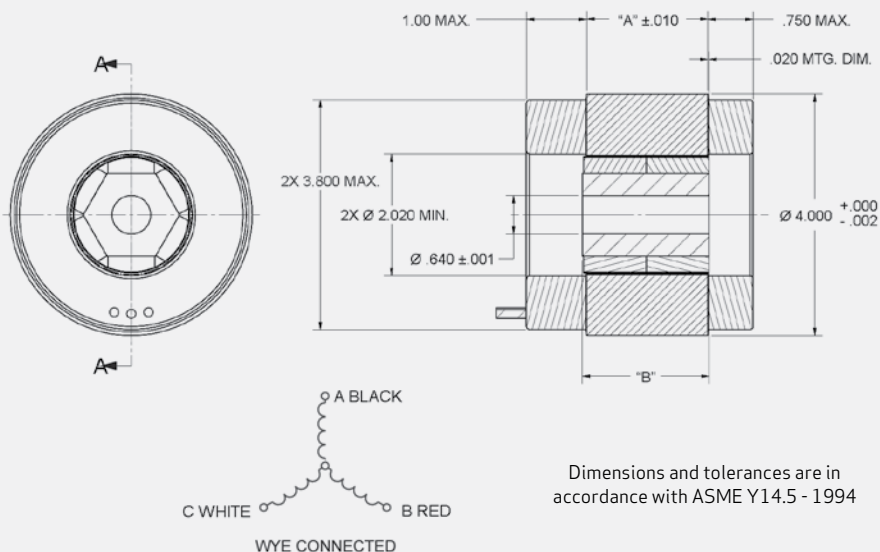
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-4000-B-1ES	2.000	2.095
DB-4000-C-1ES	3.000	3.136
DB-4000-D-1ES	4.000	4.180
DB-4000-E-1ES	5.000	5.222

DB-5000 MATRIX SERIES SPECIFICATIONS
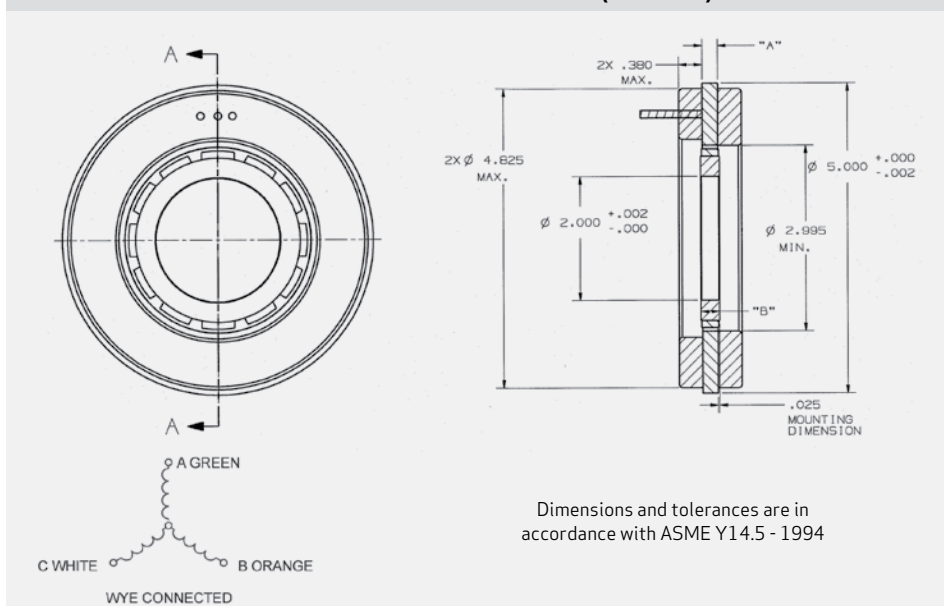
MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-5000 A-1ES	DB-5000 B-1ES	DB-5000 C-1ES	DB-5000 D-1ES	DB-5000 E-1ES	DB-5000 F-1ES	DB-5000 G-1ES	DB-5000 H-1ES
Peak Torque, T_P	oz-in	578	1207	2298	3444	4536	5644	6768	9024
Motor Constant, K_M	oz-in / √W	22.2	42.5	71.6	97.3	118.0	137.0	155.0	186.0
Number of Poles		12	12	12	12	12	12	12	12
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	31	48	74	104	135	165	200	255
Motor Inertia, J_M	oz-in-s^2	1.89E-02	3.84E-02	7.10E-02	1.04E-01	1.36E-01	1.69E-01	2.03E-01	2.68E-01
Friction Torque, T_F	oz-in	4.5	10	19	28	38	47	56	76
Electrical Time Constant, T_E	ms	1.4	2.5	3.7	4.5	5.1	5.5	5.9	6.3
Mechanical Time Constant, T_M	ms	5.45	3.02	1.96	1.55	1.38	1.27	1.20	1.10
*Temperature Rise, TPR'	°C / W	2.7	2.3	1.7	1.4	1.2	1.0	0.9	0.8
Sensors		No	No	No	No	No	No	No	No

MOTOR WINDING CONSTANTS

Specification	Units	DB-5000 A-1ES	DB-5000 B-1ES	DB-5000 C-1ES	DB-5000 D-1ES	DB-5000 E-1ES	DB-5000 F-1ES	DB-5000 G-1ES	DB-5000 H-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	72	151	287	430	567	705	846	1128
Back EMF, K_E	V per rad/s ± 10%	0.509	1.07	2.03	3.04	4.00	4.98	5.97	7.97
Terminal Resistance, R_M	ohms ± 10%	10.6	12.6	16.1	19.6	23.0	26.5	29.9	36.8
Terminal Inductance, L_M	mH ± 30%	14	32	60	89	118	147	175	233
Voltage, Stalled at Peak Torque, V_P	volts	84.6	101	129	156	184	212	239	295
Amps at Peak Torque, I_P	amps	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
**Stack lengths from 0.25 to 10.00 inches (6.35 to 254 mm) with K_t to 125 N.m/ampConsult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-5000-A-1ES	.250	.300
DB-5000-B-1ES	.550	.600
DB-5000-C-1ES	1.050	1.100
DB-5000-D-1ES	1.550	1.600
DB-5000-E-1ES	2.050	2.100
DB-5000-F-1ES	2.550	2.610
DB-5000-G-1ES	3.050	3.125
DB-5000-H-1ES	4.050	4.125

DB-6000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-6000 B-1ES	DB-6000 C-1ES	DB-6000 D-1ES	DB-6000 E-1ES	DB-6000 F-1ES	DB-6000 G-1ES
Peak Torque, T_P	oz-in	10083	8407	6727	5048	3368	1686
Motor Constant, K_M	oz-in / $\sqrt{W}$	270	243	213	178	137	80.4
Number of Poles		32	32	32	32	32	32
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	160	139	114	88	62	37
Motor Inertia, J_M	oz-in-s^2	0.637	0.532	0.427	0.321	0.216	0.111
Friction Torque, T_F	oz-in	125	104	83	62	42	19
Electrical Time Constant, T_E	ms	1.92	1.87	1.76	1.65	1.47	0.91
Mechanical Time Constant, T_M	ms	1.24	1.27	1.34	1.43	1.62	2.43
*Temperature Rise, TPR'	°C / W	0.72	0.90	1.1	1.3	1.7	2.4
Sensors		No	No	No	No	No	No

MOTOR WINDING CONSTANTS

Specification	Units	DB-6000 B-1ES	DB-6000 C-1ES	DB-6000 D-1ES	DB-6000 E-1ES	DB-6000 F-1ES	DB-6000 G-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	504	420	336	252	168	84.3
Back EMF, K_E	V per rad/s ± 10%	3.56	2.97	2.38	1.78	1.19	0.595
Terminal Resistance, R_M	ohms ± 10%	3.48	2.99	2.50	2.00	1.50	1.10
Terminal Inductance, L_M	mH ± 30%	6.7	5.6	4.4	3.3	2.2	1.0
Voltage, Stalled at Peak Torque, V_P	volts	69.8	59.9	50.0	40.0	30.0	22.0
Amps at Peak Torque, I_P	amps	20	20	20	20	20	20

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
**Stack lengths from 0.10 to 6.00 inches (2.54 to 125.4 mm) with K_T to 32.5 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.
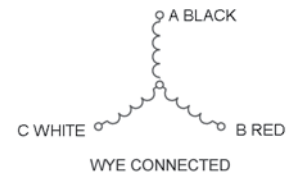
MECHANICAL DIMENSIONS (INCHES)

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-6000-B-1ES	2.950	3.050
DB-6000-C-1ES	2.450	2.550
DB-6000-D-1ES	1.950	2.050
DB-6000-E-1ES	1.450	1.550
DB-6000-F-1ES	0.950	1.050
DB-6000-G-1ES	0.450	0.550

A BLACK
C WHITE
B RED
WYE CONNECTED

DBE-6000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DBE-6000 B-2ES	DBE-6000 C-2ES	DBE-6000 D-2ES	DBE-6000 E-2ES	DBE-6000 F-2ES	DBE-6000 G-2ES
Peak Torque, T_P	oz-in	52.5	44	35	26.3	17.5	8.8
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.41	1.27	1.11	0.93	0.72	0.419
Number of Poles		32	32	32	32	32	32
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	10.5	9.2	7.6	6.0	4.4	2.8
Motor Inertia, J_M	oz-in-s^2	3.54×10^{-3}	3.04×10^{-3}	2.50×10^{-3}	1.95×10^{-3}	1.40×10^{-3}	8.51×10^{-4}
Friction Torque, T_F	oz-in	0.65	0.54	0.43	0.32	0.22	0.10
Electrical Time Constant, T_E	ms	1.9	1.9	1.8	1.7	1.4	1.0
Mechanical Time Constant, T_M	ms	1.32	1.40	1.50	1.67	2.02	3.28
*Temperature Rise, TPR'	°C / W	0.72	0.90	1.1	1.3	1.7	2.4
Sensors		Yes	Yes	Yes	Yes	Yes	Yes

MOTOR WINDING CONSTANTS

Specification	Units	DBE-6000 B-2ES	DBE-6000 C-2ES	DBE-6000 D-2ES	DBE-6000 E-2ES	DBE-6000 F-2ES	DBE-6000 G-2ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	2.63	2.19	1.75	1.31	0.875	0.439
Back EMF, K_E	V per rad/s ± 10%	3.56	2.97	2.38	1.78	1.19	0.595
Terminal Resistance, R_M	ohms ± 10%	3.48	2.99	2.5	2.00	1.50	1.10
Terminal Inductance, L_M	mH ± 30%	6.7	5.6	4.4	3.3	2.2	1.0
Voltage, Stalled at Peak Torque, V_P	volts	69.8	59.9	50.0	40.0	30.0	22.0
Amps at Peak Torque, I_P	amps	20.0	20.0	20.0	20.0	20.0	20.0

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
**Stack lengths from 0.10 to 6.00 inches (2.54 to 125.4 mm) with K_T to 32.5 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.
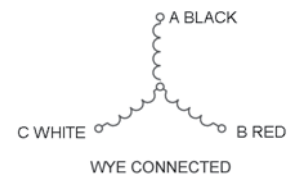
MECHANICAL DIMENSIONS (INCHES)

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DBE-6000-B-2ES	2.950	3.300
DBE-6000-C-2ES	2.450	2.800
DBE-6000-D-2ES	1.950	2.300
DBE-6000-E-2ES	1.450	1.800
DBE-6000-F-2ES	0.950	1.300
DBE-6000-G-2ES	0.450	0.800

WYE CONNECTED

DB-8000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-8000 A-1ES	DB-8000 B-1ES	DB-8000 C-1ES	DB-8000 D-1ES	DB-8000 E-1ES
Peak Torque, T_P	oz-in	18.8	37.7	58.4	75.4	96.1
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.75	1.30	1.74	2.06	2.4
Number of Poles		32	32	32	32	32
Number of Phases		3	3	3	3	3
Weight	oz (nom)	5.2	9.0	13.2	16.6	20.5
Motor Inertia, J_M	oz-in-s^2	2.1 x 10-3	3.4 x 10-3	5.5 x 10-3	6.8 x 10-3	8.3 x 10-3
Friction Torque, T_F	oz-in	0.11	0.22	0.34	0.44	0.57
Electrical Time Constant, T_E	ms	0.50	0.69	0.80	0.87	0.90
Mechanical Time Constant, T_M	ms	19.0	13.1	11.1	10.3	9.7
*Temperature Rise, TPR'	°C / W	1.3	1.0	0.83	0.71	0.62
Sensors		Yes	Yes	Yes	Yes	Yes

MOTOR WINDING CONSTANTS

Specification	Units	DB-8000 A-1ES	DB-8000 B-1ES	DB-8000 C-1ES	DB-8000 D-1ES	DB-8000 E-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	1.30	2.60	4.03	5.20	6.63
Back EMF, K_E	V per rad/s ± 10%	1.76	3.48	5.37	6.92	8.64
Terminal Resistance, R_M	ohms ± 10%	2.80	3.90	5.10	6.10	7.20
Terminal Inductance, L_M	mH ± 30%	1.4	2.7	4.1	5.3	6.5
Voltage, Stalled at Peak Torque, V_P	volts	40.6	56.9	75.0	89.7	106
Amps at Peak Torque, I_P	amps	14.5	14.6	14.7	14.7	14.7

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
**Stack lengths from 0.25 to 16.00 inches (6.35 to 406.4 mm) with K_T to 717 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

WYE CONNECTED

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994
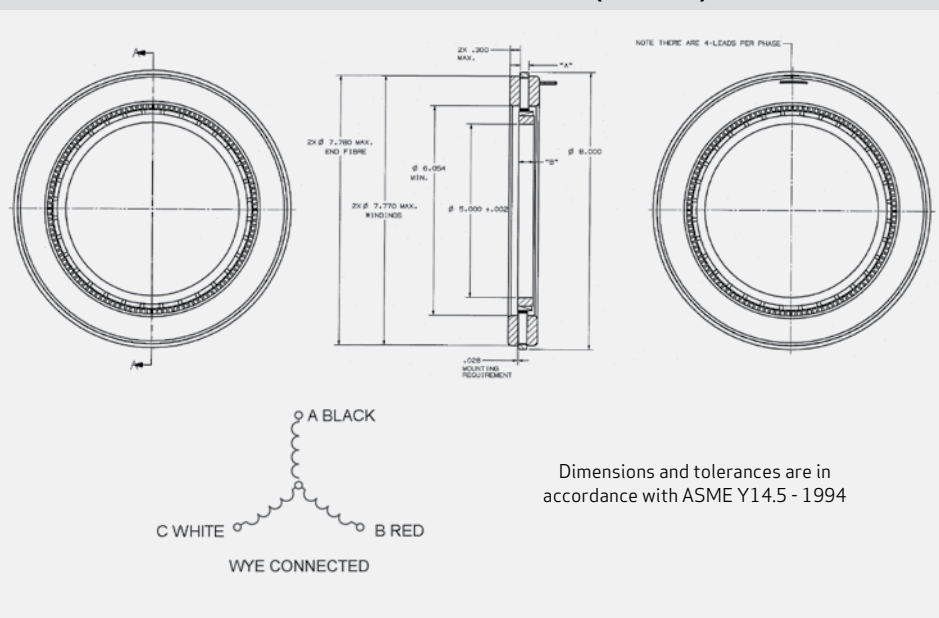
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches	"C" Inches
DB-8000-B-1ES	0.520	0.715	1.20
DB-8000-C-1ES	1.020	1.165	1.700
DB-8000-D-1ES	1.570	1.873	2.250
DB-8000-E-1ES	2.020	2.323	2.700
DB-8000-F-1ES	2.520	2.839	3.200
DB-8000-G-1ES	0.450	0.550	0.550

DBE-8000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DBE-8000 A-1ES	DBE-8000 B-1ES	DBE-8000 C-1ES	DBE-8000 D-1ES	DBE-8000 E-1ES	DBE-8000 F-1ES
Peak Torque, T_P	oz-in	18.8	37.7	58.4	75.4	96.1	9.7
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.75	1.30	1.74	2.06	2.4	0.43
Number of Poles		32	32	32	32	32	32
Number of Phases		3	3	3	3	3	3
Weight	oz (nom)	5.2	9.0	13.2	16.6	20.5	3.53
Motor Inertia, J_M	oz-in-s^2	2.1×10^{-3}	3.4×10^{-3}	5.5×10^{-3}	6.8×10^{-3}	8.3×10^{-3}	1.3×10^{-3}
Friction Torque, T_F	oz-in	0.11	0.22	0.34	0.44	0.57	6.2
Electrical Time Constant, T_E	ms	1.4	2.0	2.3	2.5	2.7	0.97
Mechanical Time Constant, T_M	ms	2.8	1.5	1.3	1.2	1.1	5.3
*Temperature Rise, TPR'	°C / W	1.3	1.0	0.82	0.71	0.61	1.5
Sensors		Yes	Yes	Yes	Yes	Yes	Yes

MOTOR WINDING CONSTANTS

Specification	Units	DBE-8000 A-1ES	DBE-8000 B-1ES	DBE-8000 C-1ES	DBE-8000 D-1ES	DBE-8000 E-1ES	DBE-8000 F-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	1.30	2.60	4.03	5.20	6.63	0.670
Back EMF, K_E	V per rad/s ± 10%	1.76	3.46	5.47	7.05	8.99	0.910
Terminal Resistance, R_M	ohms ± 10%	3.04	4.10	5.34	6.36	7.61	2.47
Terminal Inductance, L_M	mH ± 30%	4.1	8.0	12	16	20	2.4
Voltage, Stalled at Peak Torque, V_P	volts	44.1	59.5	77.5	92.3	111	35.8
Amps at Peak Torque, I_P	amps	14.5	14.5	14.5	14.5	14.5	14.5

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.

**Stack lengths from 0.25 to 16.00 inches (6.35 to 406.4 mm) with KT to 717 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

A BLACK
C WHITE
B RED
WYE CONNECTED

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DBE-8000-A-1ES	0.500	0.715
DBE-8000-B-1ES	1.000	1.165
DBE-8000-C-1ES	1.550	1.873
DBE-8000-D-1ES	2.000	2.323
DBE-8000-E-1ES	2.500	2.839
DBE-8000-F-1ES	0.250	0.445

DB-9000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-9000 G-1ES	DB-9000 H-1ES	DB-9000 I-1ES	DB-9000 J-1ES	DB-9000 K-1ES
Peak Torque, T_P	oz-in	5102	10232	15338	25560	30665
Motor Constant, K_M	oz-in / $\sqrt{W}$	176	304	405	568	636
Number of Poles		32	32	32	32	32
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	75	131	192	304	357
Motor Inertia, J_M	oz-in-s^2	0.518	1.01	1.50	2.47	2.96
Friction Torque, T_F	oz-in	53	112	171	289	348
Electrical Time Constant, T_E	ms	1.24	1.94	2.35	2.76	2.93
Mechanical Time Constant, T_M	ms	2.36	1.55	1.29	1.09	1.04
*Temperature Rise, TPR'	°C / W	1.3	0.99	0.79	0.57	0.50
Sensors		No	No	No	No	No

MOTOR WINDING CONSTANTS

Specification	Units	DB-9000 G-1ES	DB-9000 H-1ES	DB-9000 I-1ES	DB-9000 J-1ES	DB-9000 K-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	255	512	767	1278	1533
Back EMF, K_E	V per rad/s ± 10%	1.80	3.61	5.42	9.03	10.8
Terminal Resistance, R_M	ohms ± 10%	2.09	2.83	3.58	5.07	5.81
Terminal Inductance, L_M	mH ± 30%	2.6	5.5	8.4	14	17
Voltage, Stalled at Peak Torque, V_P	volts	41.8	56.6	71.6	101	116
Amps at Peak Torque, I_P	amps	20	20	20	20	20

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
**Stack lengths from 0.25 to 18.00 inches (6.35 to 457.2 mm) with KT to 1062 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

.425 MAX.   "A"   .250 MAX.

Ø9.000 +.000 -.002
Ø6.375 ±.001

2X Ø7.195 MIN.
2X Ø6.850 MAX.

2X .01 X 45°

.050 MOUNTING DIMENSION

"B"

A BLACK

C WHITE   B RED

WYE CONNECTED

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-9000-G-1ES	0.450	0.550
DB-9000-H-1ES	0.950	1.050
DB-9000-I-1ES	1.450	1.550
DB-9000-J-1ES	2.450	2.550
DB-9000-K-1ES	2.950	3.050

DB-14540 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-14540 A-1ES	DB-14540 B-1ES	DB-14540 C-1ES	DB-14540 D-1ES	DB-14540 E-1ES
Peak Torque, T_P	oz-in	21674	43273	67041	86523	108319
Motor Constant, K_M	oz-in / $\sqrt{W}$	324	579	812	976	1142
Number of Poles		32	32	32	32	32
Number of Phases		3"Y"	3"Y"	3"Y"	3"Y"	3"Y"
Weight	oz (nom)	171	312	464	584	720
Motor Inertia, J_M	oz-in-s^2	5.22	8.52	13.7	17.0	20.8
Friction Torque, T_F	oz-in	64	128	200	256	320
Electrical Time Constant, T_E	ms	1.03	1.66	2.09	2.35	2.55
Mechanical Time Constant, T_M	ms	7.05	3.59	2.95	2.53	2.26
*Temperature Rise, TPR'	°C / W	0.74	0.57	0.46	0.39	0.34
Sensors		No	No	No	No	No

MOTOR WINDING CONSTANTS

Specification	Units	DB-14540 A-1ES	DB-14540 B-1ES	DB-14540 C-1ES	DB-14540 D-1ES	DB-14540 E-1ES
**Torque Sensitivity, K_T	oz-in/amp ± 10%	639	1265	1955	2515	3149
Back EMF, K_E	V per rad/s ± 10%	4.52	8.94	13.8	17.8	22.2
Terminal Resistance, R_M	ohms ± 10%	3.90	4.77	5.80	6.64	7.60
Terminal Inductance, L_M	mH ± 30%	4.0	7.9	12	16	19
Voltage, Stalled at Peak Torque, V_P	volts	132	163	199	228	261
Amps at Peak Torque, I_P	amps	33.9	34.2	34.3	34.4	34.4

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.

**Stack lengths from 0.25 to 18.00 inches (6.35 to 457.2 mm) with KT to 1062 N.m/amp. Consult factory for additional designs. Refer to our online documentation for product updates.

MECHANICAL DIMENSIONS (INCHES)

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches	"C" Inches
DB-14540-A-1ES	0.520	0.715	1.20
DB-14540-B-1ES	1.020	1.165	1.700
DB-14540-C-1ES	1.570	1.873	2.250
DB-14540-D-1ES	2.020	2.323	2.700
DB-14540-E-1ES	2.520	2.839	3.200

DB-22000 MATRIX SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	DB-22000 -A	DB-22000 -B	DB-22000 -C	DB-22000 -D	DB-22000 -E	DB-22000 -F	DB-22000 -G
Peak Torque, T_P	lb.ft	535	1035	1542	2040	2539	3037	3535
Motor Constant, K_M	lb.ft/√W	6.34	10.7	14.3	17.4	20.0	22.5	24.7
Electrical Time Constant, $_E$	ms	1.8	2.8	3.3	3.7	4.0	4.2	4.4
Mechanical Time Constant, $_M$	ms	5.92	3.91	3.21	2.88	2.68	2.55	2.46
Power, Input, Stalled at T_P-P_P	watts	7132	9361	11591	13820	16050	18280	20509
Viscous Damping Coefficient Zero Source Impedance - F_0	lb.ft per rad/s	54	155	278	408	545	684	826
Friction Torque, T_F	lb.ft	0.73	1.2	2.2	2.9	3.7	4.4	5.1
Maximum Winding Temperature	°C	155	155	155	155	155	155	155
Temperature Rise Per Watt-TPR	°C/Watt	0.35	0.25	0.19	0.16	0.13	0.12	0.10
Number of Poles		48	48	48	48	48	48	48
Rotor Inertia - J_M	lb.ft.s^2	3.22E-01	6.06E-01	8.92E-01	1.18E+00	1.46E+00	1.74E+00	2.03E+00
Weight	lb.	48	82	115	148	181	214	248

MOTOR WINDING CONSTANTS

Specification	Units	DB-22000 -A	DB-22000 -B	DB-22000 -C	DB-22000 -D	DB-22000 -E	DB-22000 -F	DB-22000 -G
Voltage, Stalled at V_P	Volts	178	234	290	346	401	457	513
Peak Current - 1_P	Amperes	40.0	40.0	40.0	40.0	40.0	40.0	40.0
DC Resistance - R_M	Ohms	4.46	5.85	7.24	8.64	10.0	11.4	12.8
**Torque Sensitivity, K_T	lb.ft/amp	13.4	25.9	38.5	51.0	63.5	75.9	88.4
Back EMF Constant K_E	V per rad/s	18.1	35.1	52.3	69.2	86.0	103	120
Inductance - L_M	mH	8.1	16	24	32	40	48	56

*TPR as listed on the data sheets, is for an un-mounted condition unless otherwise noted. Mounted TPR values are often 50% or less than the un-mounted TPR. For air flow, the TPR may be less than 25% the un-mounted amount and for fluid cooling it may be 10% or less. Many factors affect the TPR value and its change relative to the mounting or external cooling applied. Consult the factory for an more accurate estimate of the motor's TPR.
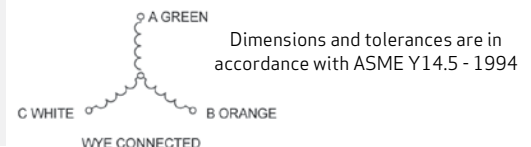**Stack lengths from 0.5 to 7.00 inches (12.7 to 177.8 mm) with K_T to 88.5 lb.ft/amp

MECHANICAL DIMENSIONS (INCHES)
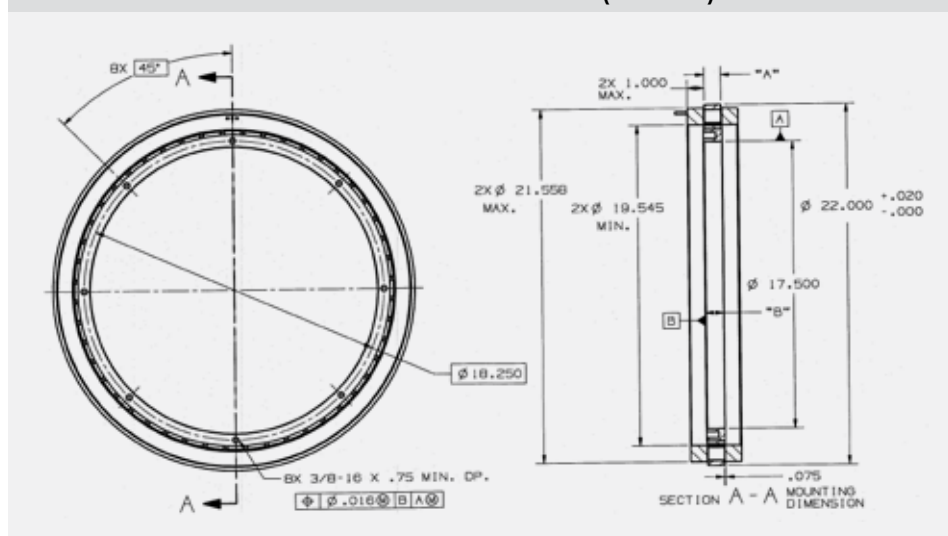
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
DB-22000-A	1.000	1.150
DB-22000-B	2.000	2.150
DB-22000-C	3.000	3.150
DB-22000-D	4.000	4.150
DB-22000-E	5.000	5.150
DB-22000-F	6.000	6.150
DB-22000-G	7.000	7.150

Dimensions and tolerances are in accordance with ASME Y14.5 - 1994

AG MATRIX™ SERIES FRAMELESS PERMANENT MAGNET ALTERNATORS

The AG Matrix™ Series alternators are used in applications that require high power density. The designs are optimized for maximum output power and maximum efficiency. Utilizing high energy rare earth magnets and dense slot fills, the AG Series achieves higher AC output power. This provides the highest performance per volume and minimizes the alternators footprint within the system.

The alternators are supplied as a direct drive rotor / stator frameless part set that is directly attached to the load. This form of attachment eliminates backlash and increases stiffness for an optimized direct drive system.

The AG Matrix Series is a family of alternators consisting of a wide range of sizes, outside diameters from 5.25 to 22 inches (133.35 mm to 558.8 mm) with multiple stack sizes and winding options for each diameter.

Along with our standard Matrix alternators, our engineers design custom solutions. If our existing models don't meet your needs, we will tailor them or provide options for a best value solution to meet your exact requirements.

FEATURES

- Compact
- Continuous AC output power from 345 W to over 36 kW
- Double insulated high temp magnet wire minimizes leakage current and provides good thermal resistance
- Stable high temp encapsulation material minimizes movement or working of windings under large temperature variations.
- Rare earth magnets
- High power density
- Large through bores

TYPICAL APPLICATIONS

- Auxiliary power generation
- Wind energy
- Onboard power generation for manned and unmanned vehicles

AG MATRIX™ SERIES OVERVIEW

A permanent magnet alternator is a power generating device that produces a sinusoidal output when a mechanical input to its hub or shaft is applied. This device is constructed very much like a brushless motor with the appropriate selection of insulation materials and winding to match the environment and application. Essentially, a permanent magnet alternator is to a brushless motor what a tachometer is to a brush-type motor except that the alternator's application is power generation instead of rate feedback.

Design Considerations

All diameters listed have finished ground lamination surfaces. They can be complemented with rings and hubs for mounting convenience. If you require a housing that may also include bearings, torquer motor, synchro, potentiometer, or similar components, we can design the entire assembly to meet your mechanical dimensions and performance requirements.

Mounting Considerations

Since torque motors are normally delivered in kit form, you provide the mounting surfaces and bearings. When you design the mechanics of the mount, be sure to observe these rules:

1. Eccentricities from the inner member mounting surface should not exceed 0.004 inches for rare earth motor designs.

2. The bore of the mounting surface should be perpendicular to the mounting seat within 0.002 inches for rare earth designs.

Electrical Considerations

For each mechanical configuration shown, different winding designs to modify AC output voltage, output power or speed can be supplied by Moog to suit your system requirement. In each case, you have the option of selecting one of the existing designs or specifying a new winding designed to meet your exact requirements.

OPTIONS

- Winding options to adjust the output power and output voltage
- Varying stack lengths from 0.10 to over 30 inches (2.54 to 762 mm)
- Mounting flanges, hubs, mounting holes and connectors may be added as required

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PART NUMBERING SYSTEM GUIDE
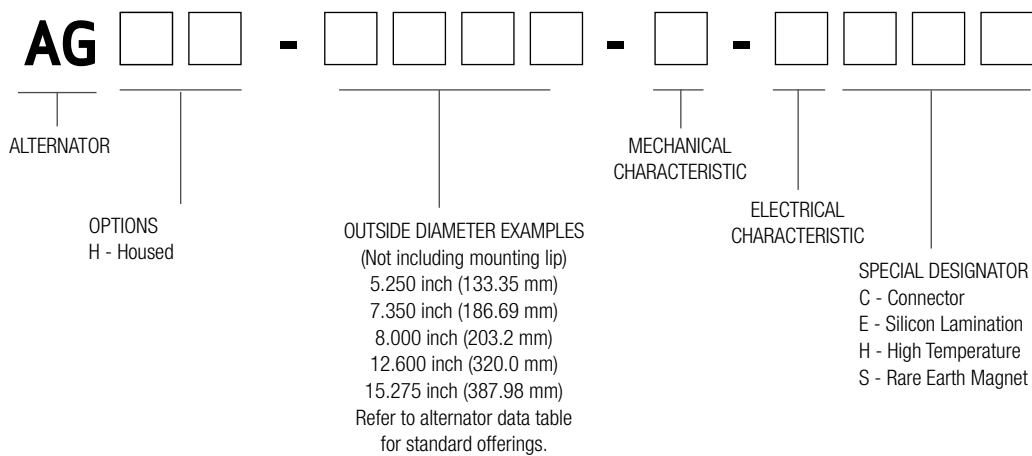
AG ☐☐ - ☐☐☐☐ - ☐ - ☐☐☐☐

ALTERNATOR

OPTIONS
H - Housed

OUTSIDE DIAMETER EXAMPLES
(Not including mounting lip)
5.250 inch (133.35 mm)
7.350 inch (186.69 mm)
8.000 inch (203.2 mm)
12.600 inch (320.0 mm)
15.275 inch (387.98 mm)
Refer to alternator data table
for standard offerings.

MECHANICAL
CHARACTERISTIC

ELECTRICAL
CHARACTERISTIC

SPECIAL DESIGNATOR
C - Connector
E - Silicon Lamination
H - High Temperature
S - Rare Earth Magnet

The following frame sizes represent only a small sampling of the total range manufactured. Consult factory for additional designs. Refer to our online documentation for product updates.

Note: Additional alternator proudcts available, see GES Alternators at **www.moog.com**.

AG-5250 SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C							
Specification	Units	AG-5250 A-1ES	AG-5250 B-1ES	AG-5250 C-1ES	AG-5250 D-1ES	AG-5250 E-1ES	AG-5250 F-1ES
Continuous Rated Power	w	345	529	717	903	1031	1400
Rated Speed Power	rpm	650	650	650	650	650	650
Voltage at Rated Power	V rms	237	242	244	247	247	250
Current at Rated Power	Amps rms	0.84	1.26	1.74	2.11	2.42	3.23
Efficiency at Rated Power	%	78	80	82	84	85	86
Input Torque at Rated Speed	lb.ft (n.m)	5.06 (6.86)	7.39 (10.02)	9.76 (13.24)	12.10 (16.41)	13.80 (18.71)	18.40 (24.95)
Weight	lb (Kg)	5.2 (2.36)	7.2 (3.27)	9.1 (4.13)	10.9 (4.94)	12.7 (5.76)	16.5 (7.48)
OD*	inches (mm)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)
ID	inches (mm)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)

MOTOR CHARACTERISTICS @ 25° C							
Specification	Units	AG-5250 A-2ES	AG-5250 B-2ES	AG-5250 C-2ES	AG-5250 D-2ES	AG-5250 E-2ES	AG-5250 F-2ES
Continuous Rated Power	w	1000	1411	1895	2343	2708	3590
Rated Speed Power	rpm	1500	1500	1500	1500	1500	1500
Voltage	V rms	260	260	238	260	263	259
Current	Amps rms	2.24	3.13	4.29	5.20	5.94	8.01
Efficiency	%	90	90	90	91	90	91
Input Torque at Rated Speed	lb.ft (n.m)	5.44 (7.38)	7.55 (10.204)	10.10 (13.70)	12.40 (16.81)	14.30 (19.39)	18.90 (25.63)
Weight	lb (Kg)	5.2 (2.36)	7.2 (3.247)	9.1 (4.13)	10.9 (4.94)	12.8 (5.80)	16.6 (7.53)
OD*	inches (mm)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)	5.250 (133.35)
ID	inches (mm)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)	2.35 (59.69)

MECHANICAL DIMENSIONS (INCHES)
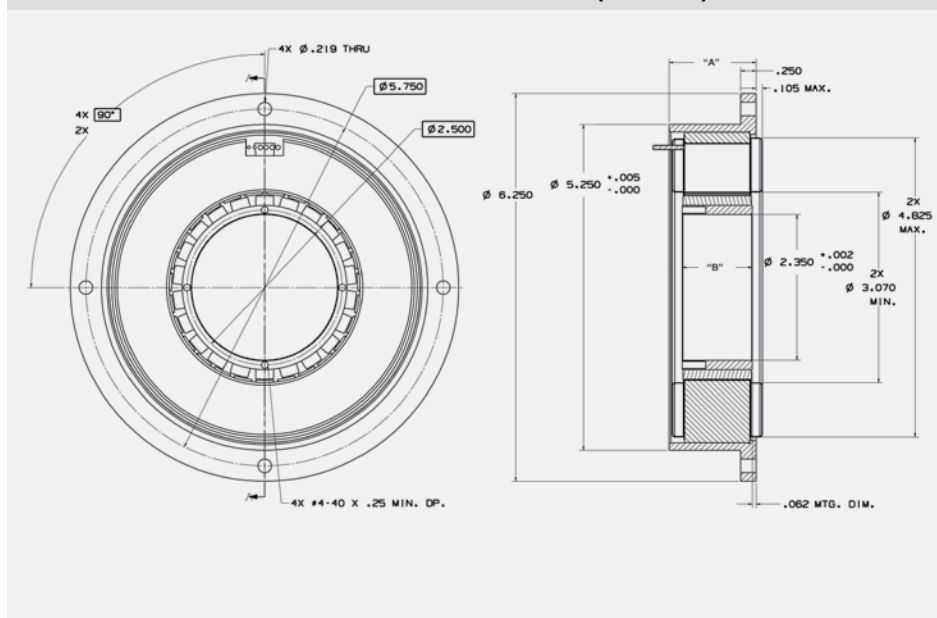
LENGTH DIMENSIONS

Modular	"A" inches (mm)	"B" inches (mm)
AG-5250-A-1ES	1.4 (35.56)	1.125 (28.575)
AG-5250-A-2ES	1.4 (35.56)	1.125 (28.575)
AG-5250-B-1ES	1.9 (48.26)	1.625 (41.275)
AG-5250-B-2ES	1.9 (48.26)	1.625 (41.275)
AG-5250-C-1ES	2.4 (60.96)	2.125 (53.975)
AG-5250-C-2ES	2.4 (60.96)	2.125 (53.975)
AG-5250-D-1ES	2.9 (73.66)	2.725 (69.215)
AG-5250-D-2ES	2.9 (73.66)	2.725 (69.215)
AG-5250-E-1ES	3.4 (86.36)	3.225 (81.915)
AG-5250-E-2ES	3.4 (86.36)	3.225 (81.915)
AG-5250-F-1ES	4.4 (111.76)	4.225 (107.315)
AG-5250-F-2ES	4.4 (111.76)	4.225 (107.315)

# AG-7350 SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C									
Specification	Units	AG-7350 A-1ES	AG-7350 B-1ES	AG-7350 C-1ES	AG-7350 D-1ES	AG-7350 E-1ES	AG-7350 F-1ES	AG-7350 G-1ES	AG-7350 H-1ES
Continuous Rated Power	w	868	1304	1727	2177	2603	3027	3319	4181
Rated Speed Power	rpm	600	600	600	600	600	600	600	600
Voltage	V rms	232	229	230	227	231	227	231	227
Current	Amps rms	4.08	3.29	4.33	5.53	6.51	7.69	8.31	10.6
Efficiency	%	85	87	88	89	89	90	90	90
Input Torque at Rated Speed	lb.ft (n.m)	12.40 (16.81)	18.00 (24.41)	23.60 (32.00)	29.40 (39.87)	34.90 (47.32)	40.40 (54.78)	44.3 (60.07)	55.5 (75.26)
Weight	lb (Kg)	10.5 (4.76)	14.5 (6.58)	18.0 (8.17)	22.0 (9.98)	25.5 (11.57)	30.0 (13.61)	33.0 (14.97)	40.0 (18.14)
OD*	inches (mm)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)
ID	inches (mm)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)

MOTOR CHARACTERISTICS @ 25° C									
Specification	Units	AG-7350 A-2ES	AG-7350 B-2ES	AG-7350 C-2ES	AG-7350 D-2ES	AG-7350 E-2ES	AG-7350 F-2ES	AG-7350 G-2ES	AG-7350 H-2ES
Continuous Rated Power	w	1904	2872	3751	4561	5421	6360	7356	8550
Rated Speed Power	rpm	1200	1200	1200	1200	1200	1200	1200	1200
Voltage	V rms	230	230	233	236	238	239	228	229
Current	Amps rms	1.79	7.22	8.95	11.2	13.1	15.3	18.6	21.6
Efficiency	%	91	92	92	92	92	92	92	92
Input Torque at Rated Speed	lb.ft (n.m)	12.50 (16.95)	18.70 (25.36)	23.60 (32.00)	29.50 (40.00)	35.00 (47.46)	41.00 (55.60)	47.4 (64.27)	55.1 (74.72)
Weight	lb (Kg)	10.5 (4.76)	14.5 (6.58)	18.0 (8.17)	22.0 (9.98)	25.5 (11.57)	30.0 (13.61)	33.0 (14.97)	40.0 (18.14)
OD*	inches (mm)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)	7.350 (186.69)
ID	inches (mm)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)	3.350 (85.09)

AG-7350 SERIES SPECIFICATIONS

MECHANICAL DIMENSIONS (INCHES)
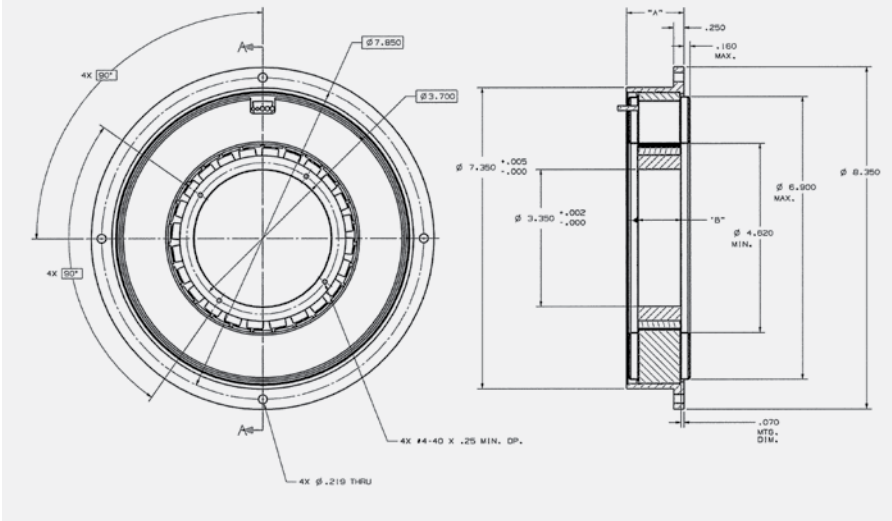
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
AG-7350-A-1ES	1.40 (35.56)	1.050 (26.67)
AG-7350-A-2ES	1.40 (35.56)	1.050 (26.67)
AG-7350-B-1ES	1.90 (48.26)	1.550 (39.37)
AG-7350-B-2ES	1.90 (48.26)	1.550 (39.37)
AG-7350-C-1ES	2.40 (60.96)	2.075 (52.705)
AG-7350-C-2ES	2.40 (60.96)	2.075 (52.705)
AG-7350-D-1ES	2.890 (73.406)	2.757 (70.028)
AG-7350-D-2ES	2.890 (73.406)	2.757 (70.028)
AG-7350-E-1ES	3.40 (86.36)	3.075 (78.105)
AG-7350-E-2ES	3.40 (86.36)	3.075 (78.105)
AG-7350-F-1ES	3.90 (99.06)	3.600 (91.44)
AG-7350-F-2ES	3.90 (99.06)	3.600 (91.44)
AG-7350-G-1ES	4.40 (111.76)	4.100 (104.14)
AG-7350-G-2ES	4.40 (111.76)	4.100 (104.14)
AG-7350-H-1ES	5.40 (137.16)	5.125 (130.175)
AG-7350-H-2ES	5.40 (137.16)	5.125 (130.175)

AG-12600 SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C							
Specification	Units	AG-12600 A-1ES	AG-12600 B-1ES	AG-12600 C-1ES	AG-12600 D-1ES	AG-12600 E-1ES	AG-12600 F-1ES
Continuous Rated Power	w	966	2149	3681	4737	5966	7049
Rated Speed Power	rpm	250	250	250	250	250	250
Voltage	V rms	256	265	283	278	282	280
Current	Amps rms	2.18	4.68	7.27	9.82	12.23	14.52
Efficiency	%	79	85	86	87	88	89
Input Torque at Rated Speed	lb.ft (n.m)	35.8 (48.54)	73.0 (99.99)	120.0 (162.72)	154.0 (208.82)	193.0 (261.71)	227.0 (307.81)
Weight	lb (Kg)	21.0 (9.53)	36.0 (16.33)	51.0 (23.13)	65.0 (29.48)	80.0 (36.29)	96.0 (43.55)
OD*	inches (mm)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)
ID	inches (mm)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)

MOTOR CHARACTERISTICS @ 25° C							
Specification	Units	AG-12600 A-2ES	AG-12600 B-2ES	AG-12600 C-2ES	AG-12600 D-2ES	AG-12600 E-2ES	AG-12600 F-2ES
Continuous Rated Power	w	3874	7998	12281	16388	20941	23986
Rated Speed Power	rpm	800	800	800	800	800	800
Voltage	V rms	280	285	301	284	297	277
Current	Amps rms	7.98	163.17	22.75	33.02	40.31	49.27
Efficiency	%	90	90	91	91	91	91
Input Torque at Rated Speed	lb.ft (n.m)	37.7 (51.12)	76.8 (104.14)	118.0 (160.01)	157.0 (212.89)	201.0 (272.56)	230.0 (311.88)
Weight	lb (Kg)	21.0 (9.53)	36.0 (16.33)	51.0 (23.13)	65.0 (29.48)	80.0 (36.29)	96.0 (43.55)
OD*	inches (mm)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)	12.60 (320.0)
ID	inches (mm)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)	8.75 (222.25)

MECHANICAL DIMENSIONS (INCHES)
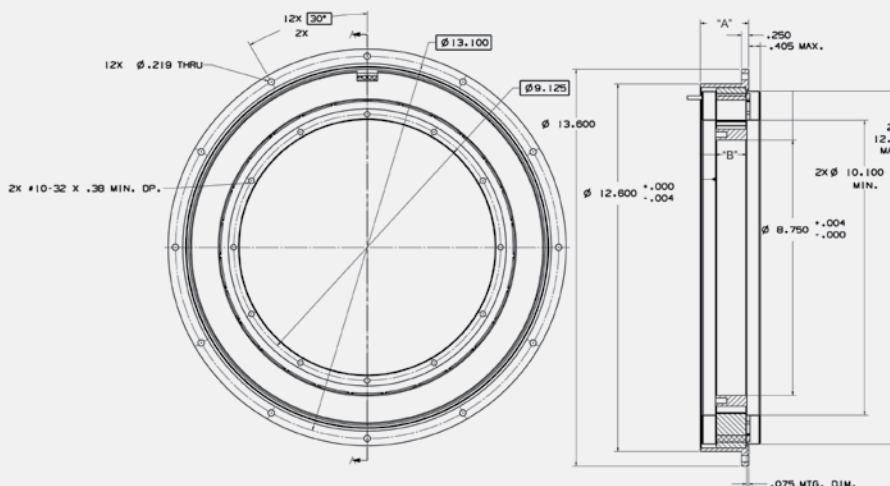
MOUNTING DIMENSIONS

Modular	"A" Inches	"B" Inches
AG-12600-A-1ES	1.6 (40.64)	1.05 (26.67)
AG-12600-A-2ES	1.6 (40.64)	1.05 (26.67)
AG-12600-B-1ES	2.6 (66.04)	2.075 (52.71)
AG-12600-B-2ES	2.6 (66.04)	2.075 (52.71)
AG-12600-C-1ES	3.6 (91.44)	3.10 (78.74)
AG-12600-C-2ES	3.6 (91.44)	3.10 (78.74)
AG-12600-D-1ES	4.6 (116.84)	4.125 (104.775)
AG-12600-D-2ES	4.6 (116.84)	4.125 (104.775)
AG-12600-E-1ES	5.6 (142.24)	5.15 (130.81)
AG-12600-E-2ES	5.6 (142.24)	5.15 (130.81)
AG-12600-F-1ES	6.6 (167.64)	6.2 (157.48)
AG-12600-F-2ES	6.6 (167.64)	6.2 (157.48)

# AG-15275 SERIES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	AG-15275 A-1ES	AG-15275 B-1ES	AG-15275 C-1ES	AG-15275 D-1ES	AG-15275 E-1ES	AG-15275 F-1ES	AG-15275 G-1ES	AG-15275 H-1ES
Continuous Rated Power	w	1631	3594	5653	7392	9401	11141	12707	15042
Rated Speed Power	rpm	220	220	220	220	220	220	220	220
Voltage	V rms	248	307	293	289	260	298	263	285
Current	Amps rms	3.8	6.75	11.2	14.7	20.9	21.6	27.8	30.5
Efficiency	%	82	87	82	84	85	85	86	86
Input Torque at Rated Speed	lb.ft (n.m)	65.7 (89.09)	135.0 (183.06)	207.0 (280.96)	269.0 (364.76)	340.0 (461.04)	402.0 (545.11)	458.0 (621.05)	539.0 (730.88)
Weight	lb (Kg)	38.0 (17.24)	65.0 (29.48)	92.0 (41.73)	120.0 (54.43)	150.0 (68.04)	175.0 (79.38)	200.0 (90.72)	230.0 (104.34)
OD*	inches (mm)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)
ID	inches (mm)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	AG-15275 A-2ES	AG-15275 B-2ES	AG-15275 C-2ES	AG-15275 D-2ES	AG-15275 E-2ES	AG-15275 F-2ES	AG-15275 G-2ES	AG-15275 H-2ES
Continuous Rated Power	w	6892	14706	21282	29237	32922	32960	31121	36526
Rated Speed Power	rpm	800	800	800	800	700	600	500	500
Voltage	V rms	267	322	289	291	283	288	281	280
Current	Amps rms	15.1	26.5	4.3	58.0	65.8	66	63.2	75.2
Efficiency	%	90	90	90	90	91	90	90	90
Input Torque at Rated Speed	lb.ft (n.m)	67.4 (91.99)	141.0 (191.20)	205.0 (277.98)	283.0 (383.75)	363.0 (492.23)	423.0 (573.59)	479.0 (649.52)	562.0 (762.07)
Weight	lb (Kg)	38.0 (17.24)	65.0 (29.48)	92.0 (41.73)	120.0 (54.43)	150.0 (68.04)	175.0 (79.38)	200.0 (90.72)	230.0 (104.34)
OD*	inches (mm)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)	15.275 (387.99)
ID	inches (mm)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)	10.157 (257.99)

AG-15275 SERIES SPECIFICATIONS

MECHANICAL DIMENSIONS (INCHES)
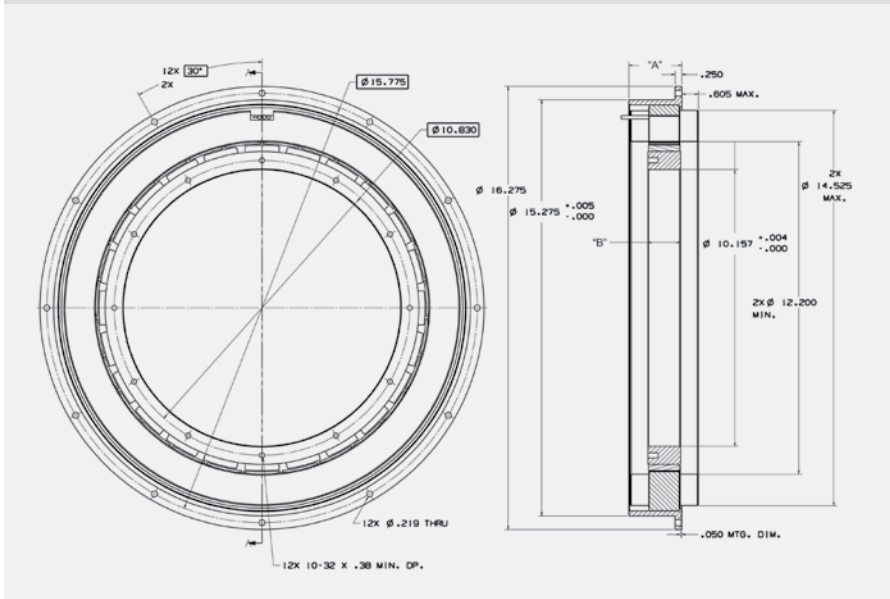
MOUNTING DIMENSIONS		
Modular	"A" Inches	"B" Inches
AG-15275-A-1ES	1.95 (49.53)	1.2 (30.48)
AG-15275-A-2ES	1.95 (49.53)	1.2 (30.48)
AG-15275-B-1ES	3.05 (77.47)	2.3 (58.42)
AG-152750-B-2ES	3.05 (77.47)	2.3 (58.42)
AG-15275-C-1ES	4.15 (105.41)	3.45 (87.63)
AG-15275-C-2ES	4.15 (105.41)	3.45 (87.63)
AG-15275-D-1ES	5.25 (133.35)	4.575 (119.21)
AG-15275-D-2ES	5.25 (133.35)	4.575 (119.21)
AG-15275-E-1ES	6.35 (161.29)	5.7 (144.78)
AG-15275-E-2ES	6.35 (161.29)	5.7 (144.78)
AG-15275-F-1ES	7.45 (189.23)	6.825 (173.36)
AG-15275-F-2ES	7.45 (189.23)	6.825 (173.36)
AG-15275-G-1ES	8.55 (217.17)	7.95 (201.93)
AG-15275-G-2ES	8.55 (217.17)	7.95 (201.93)
AG-15275-H-1ES	9.65 (245.11)	9.075 (230.51)
AG-15275-H-2ES	9.65 (245.11)	9.075 (230.51)
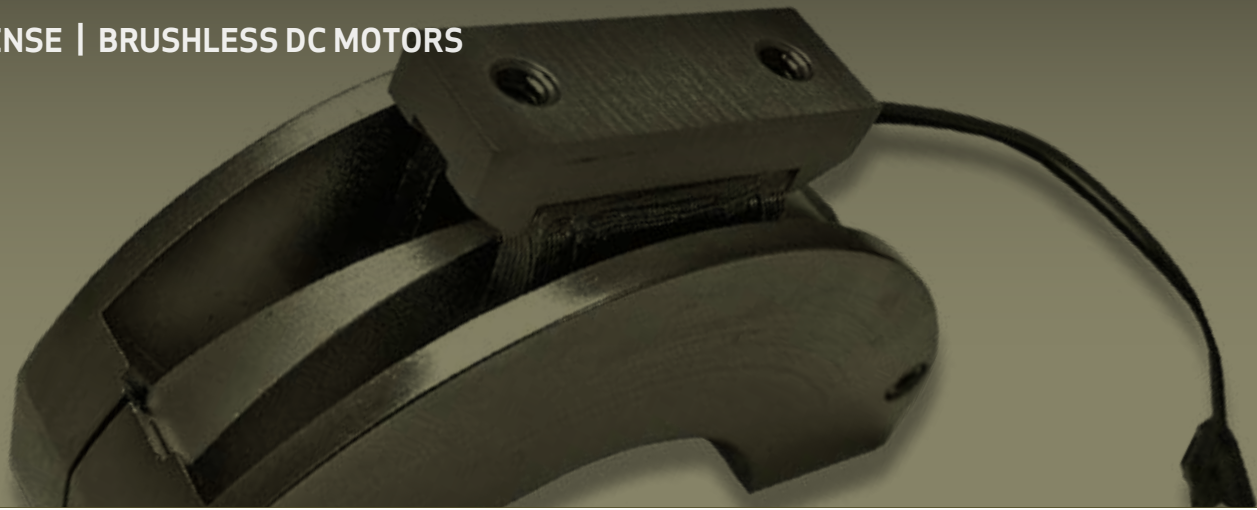
LIMITED ROTATION SECTIONAL TORQUE MOTORS

Limited rotation sectional torque motors are unique motion components that can be used to control or move elements that only require limited rotation. These devices provide very linear torque and high acceleration. They are ideal for limited movement applications where space is critical, no room for a full sized round motor.

Since the angle of rotation is limited, these motors require no commutation, which makes the design brushless, regardless of the excitation method used. The brushless design means that there is no brush wear debris to contend with in applications where cleanliness is an issue.

These devices are supplied as a parts-set and are intended to use existing structures as their supporting elements. This concept reduces the total mass of the complete assembly by eliminating redundant support structures and reduces total system cost.

BENEFITS

• Provides a consistent torque over a limited angle
• Saves physical space
• Ripple free operation
• Less friction
• Better heat dissipation
• Winding is on the outside element, namely the stator
• No cogging
• Two leads: simpler electronics
• Excellent form-factor: allows for use in very tight volume
• Integrate feedback devices

TYPICAL APPLICATIONS

• Missiles, precision guided munition and radar applications
• Short and medium range missiles with small diameters
• Small diameter FLIRs
• Scanners

STROKE INFORMATION	
Model	Stroke
AS-912-001	± 35.5°
AS-912-002	± 35.5°
AS-913-001	± 33.0°
AS-913-002	± 28.5°

DB SERIES FRAMELESS BRUSHLESS DC TORQUE MOTORS

The DB Series brushless torque motors are used in applications that require high power density and / or quick accelerations. The designs are optimized to minimize input power for maximum efficiency.

Utilizing high energy rare earth magnets and dense slot fills, the DB Series achieves high Km values. This provides the highest performance per volume and minimizes the motor footprint within the system.

The motors are supplied as a direct drive rotor / stator frameless part set that is directly attached to the load. This form of attachment eliminates backlash and increases servo stiffness for an optimized direct drive system.

The DB Series motors consist of a wide range of sizes and performance.

Our engineers design custom solutions. If an existing model does not meet your needs, we will tailor them or provide options for a best value solution to meet your exact requirements.

FEATURES

- Compact
- Peak torques from 21 to over 650,000 oz-in (0.148 to 4590 N.m)
- Double insulated high temp magnet wire minimizes leakage current and provides good thermal resistance
- Stable high temp encapsulation material minimizes movement or working of windings under large temperature variations.
- Rare earth magnets
- High power density
- High torque to inertia ratio
- Low speed with high accuracy
- Large through bores

BENEFITS

- Operate over a wide range of speeds - not limited to AC frequency
- Extremely quiet operation with long life capability
- Motor life is not limited to brush or commutator life
- Efficient operation without losses associated with brushes

TYPICAL APPLICATIONS

- Speed and rotation control systems
- Gimbals for FLIR and inertial navigation systems
- Stabilized gun and fire control systems for combat vehicles
- Fire control radars for land and shipboard defense
- Cockpit instrumentation for military and commercial aircraft
- Space and vacuum instruments, actuation systems and momentum wheels

DB MATRIX™ SERIES OVERVIEW

A brushless DC torque motor is a motor which is electronically commutated and exhibits the linear speed torque characteristic of a conventional DC motor. The performance of the brushless DC motor is dependent on the commutation of current in the motor windings, which is controlled by a separate electronic controller. Most controllers require some type of position feedback for proper operation. Common feedback devices are Hall Effect sensors, resolvers and encoders. Moog offers all three types and provides technical assistance in choosing the correct sensor for your application.

Design Considerations

All diameters listed have finished ground lamination surfaces. They can be complemented with rings and hubs for mounting convenience. If you require a housing that may also include bearings, torquer motor, synchro, potentiometer, or similar components, we can design the entire assembly to meet your mechanical dimensions and performance requirements.

Mounting Considerations

Since torque motors are normally delivered in kit form, you provide the mounting surfaces and bearings. When you design the mechanics of the mount, be sure to observe these rules:

1. Eccentricities from the inner member mounting surface should not exceed 0.004 inches for rare earth motor designs.

2. The bore of the mounting surface should be perpendicular to the mounting seat within 0.002 inches for rare earth designs.

Electrical Considerations

For each mechanical configuration shown, different winding designs to modify torque, torque sensitivity, DC resistance, can be supplied by Moog to suit your system requirement. In each case, you have the option of selecting one of the existing designs or specifying a new winding designed to meet your exact requirements.

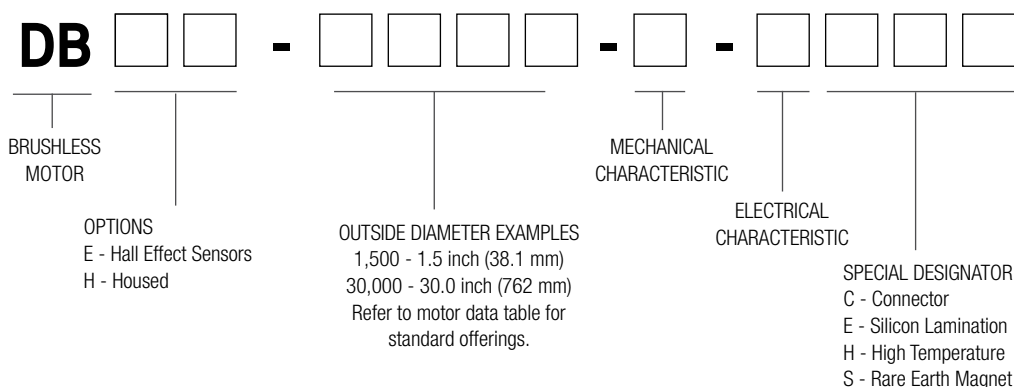| TABLE 1			
Parameter	Symbol	Units	Relationship To Published Parameter
Electrical Time Constant	τ_E	ms	L_M / R_M
Mechanical Time Constant	τ_M	ms	$J_M \bullet R_M$ $K_E \bullet K_T$
Power Input, Stalled At Peak Torque (25°C)	P_P	watts	$V_P \bullet I_P$
Viscous Damping Coefficients Zero Source Impedance Infinite Source Impedance	F_O F_I	oz-in per rad/s oz-in per rad/s	$K_T \bullet K_E$ R_M Small % of F_O
Motor Friction Torque (Actual)	T_F	oz-in	T_F
Maximum Power Rate	P	oz-in / s^2	T_P^2 / J_M
Maximum Theoretical Acceleration	$\propto_M$		T_P / J_M
Theoretical No Load Speed	ω_{NL}		V_P / K_E

[1] T_F is specified as a maximum value and includes brush friction, magnetic detent and test fixture bearing friction which is considered negligible.

[2] In cases where motor is to be operated at some voltage less than V_P due to power supply limitations the new ω_{NL} becomes V_A / K_E where V_A = voltage applied.

OPTIONS

- Winding options to adjust torque sensitivity, back EMF, DC resistance for matching a variety of system requirements
- Varying stack lengths from 0.25 to 2.5 inches (6.35 to 63.5 mm)
- Mounting flanges, hubs, mounting holes and connectors may be added as required
- Hall effect sensors for commutation

PART NUMBERING SYSTEM GUIDE

DB ☐☐ - ☐☐☐☐ - ☐ - ☐☐☐☐

BRUSHLESS MOTOR

OPTIONS
E - Hall Effect Sensors
H - Housed

OUTSIDE DIAMETER EXAMPLES
1,500 - 1.5 inch (38.1 mm)
30,000 - 30.0 inch (762 mm)
Refer to motor data table for standard offerings.

MECHANICAL CHARACTERISTIC

ELECTRICAL CHARACTERISTIC

SPECIAL DESIGNATOR
C - Connector
E - Silicon Lamination
H - High Temperature
S - Rare Earth Magnet

The following frame sizes represent only a small sampling of the total range manufactured. Consult factory for additional designs. Refer to our online documentation for product updates.
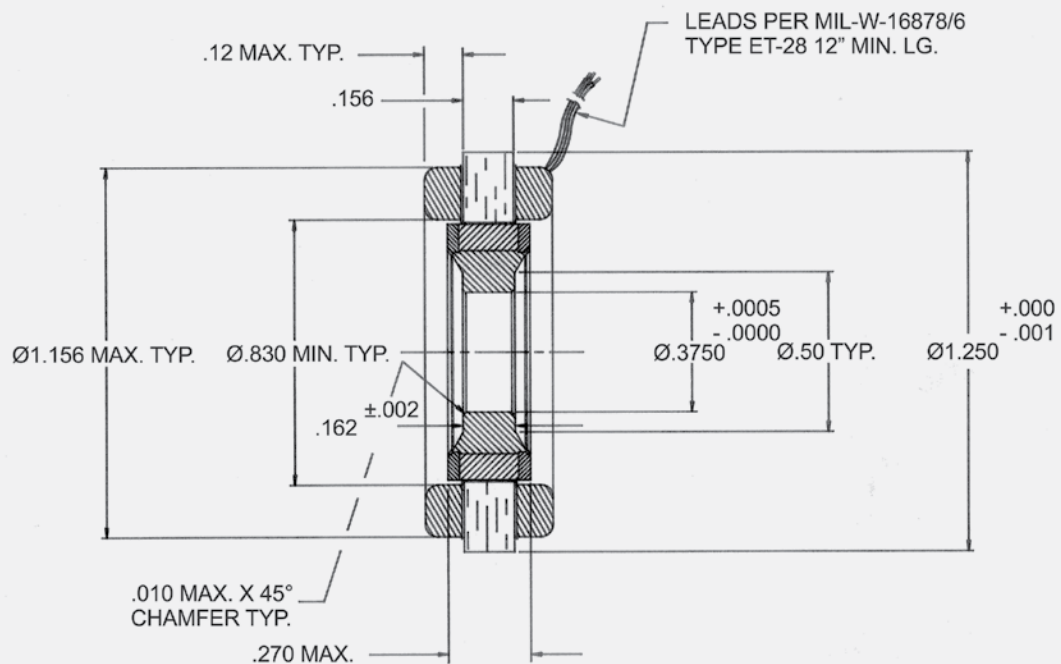
DB-1250-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	1.4
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.11
Number of Poles		8
Number of Phases		3"Δ"
Weight	oz (nom)	1
Motor Inertia, J_M	oz-in-s^2	1.22E-04
Friction Torque, T_F	oz-in	0.35
Electrical Time Constant, T_E	ms	0.09
Mechanical Time Constant, T_M	ms	14.10
*Temperature Rise, TPR'	°C / W	29.6
Integral Feedback Device		None

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	7
Back EMF, K_E	V per rad/s ± 10%	0.049
Terminal Resistance, R_M	ohms ± 10%	40
Terminal Inductance, L_M	mH ± 30%	3.7
Voltage, Stalled at Peak Torque, V_P	volts	8
Amps at Peak Torque, I_P	amps	0.20

MECHANICAL DIMENSIONS (INCHES)

DB-1500-G-4 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	53
Motor Constant, K_M	oz-in / $\sqrt{W}$	6.27
Number of Poles		8
Number of Phases		3"Y"
Weight	oz (nom)	7
Motor Inertia, J_M	oz-in-s^2	4.53E-03
Friction Torque, T_F	oz-in	1
Electrical Time Constant, T_E	ms	0.47
Mechanical Time Constant, T_M	ms	16.31
*Temperature Rise, TPR'	°C / W	9.8
Integral Feedback Device		None

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	11.9
Back EMF, K_E	V per rad/s ± 10%	0.084
Terminal Resistance, R_M	ohms ± 10%	3.6
Terminal Inductance, L_M	mH ± 30%	1.7
Voltage, Stalled at Peak Torque, V_P	volts	16.1
Amps at Peak Torque, I_P	amps	4.46

MECHANICAL DIMENSIONS (INCHES)
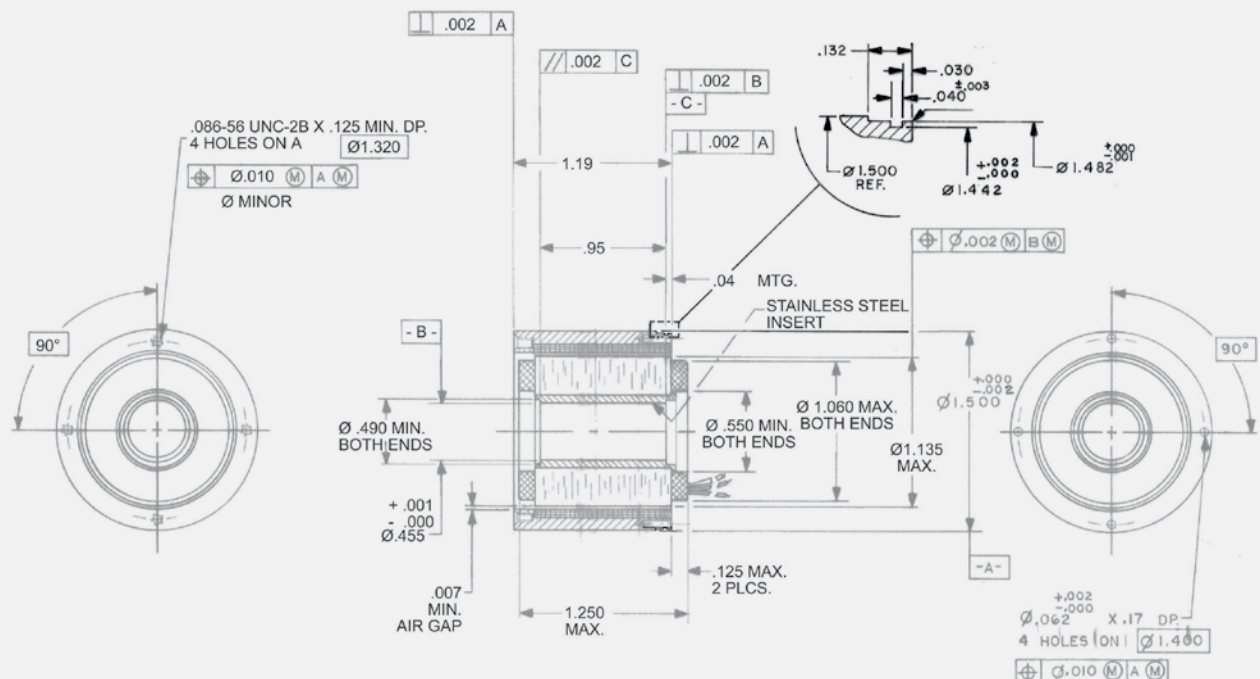
DB-1840-K-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	243.9
Motor Constant, K_M	oz-in / $\sqrt{W}$	11.85
Number of Poles		6
Number of Phases		3"Y"
Weight	oz (nom)	14
Motor Inertia, J_M	oz-in-s^2	4.80E-04
Friction Torque, T_F	oz-in	1.8
Electrical Time Constant, T_E	ms	0.884
Mechanical Time Constant, T_M	ms	0.48
*Temperature Rise, TPR'	°C / W	2
Integral Feedback Device		Halls

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	7.77
Back EMF, K_E	V per rad/s ± 10%	0.055
Terminal Resistance, R_M	ohms ± 10%	0.43
Terminal Inductance, L_M	mH ± 30%	0.38
Voltage, Stalled at Peak Torque, V_P	volts	13.5
Amps at Peak Torque, I_P	amps	31.4

MECHANICAL DIMENSIONS (INCHES)
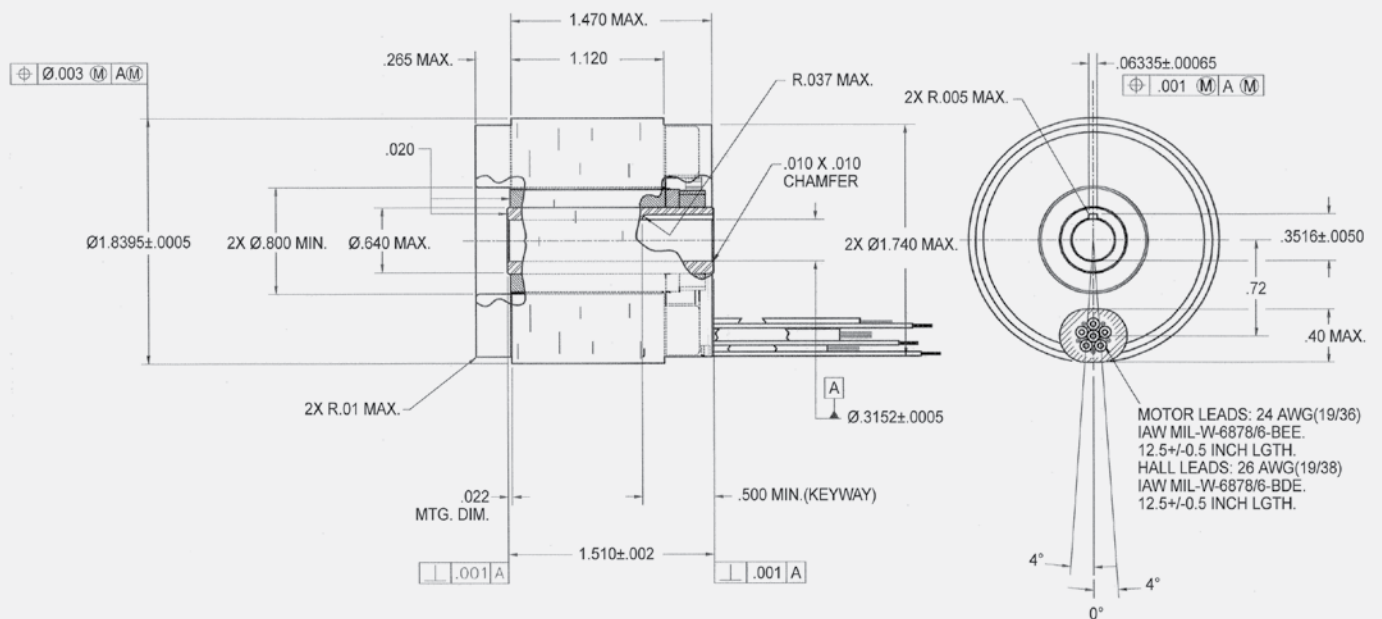
DB-1890-A-1S SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	45
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.52
Number of Poles		16
Number of Phases		3"Y"
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	9.00E-04
Friction Torque, T_F	oz-in	2.0
Electrical Time Constant, T_E	ms	0.04
Mechanical Time Constant, T_M	ms	20.11
*Temperature Rise, TPR'	°C / W	18.5
Integral Feedback Device		No

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	3.90
Back EMF, K_E	V per rad/s ± 10%	0.028
Terminal Resistance, R_M	ohms ± 10%	2.40
Terminal Inductance, L_M	mH ± 30%	0.11
Voltage, Stalled at Peak Torque, V_P	volts	27.8
Amps at Peak Torque, I_P	amps	11.6

MECHANICAL DIMENSIONS (INCHES)
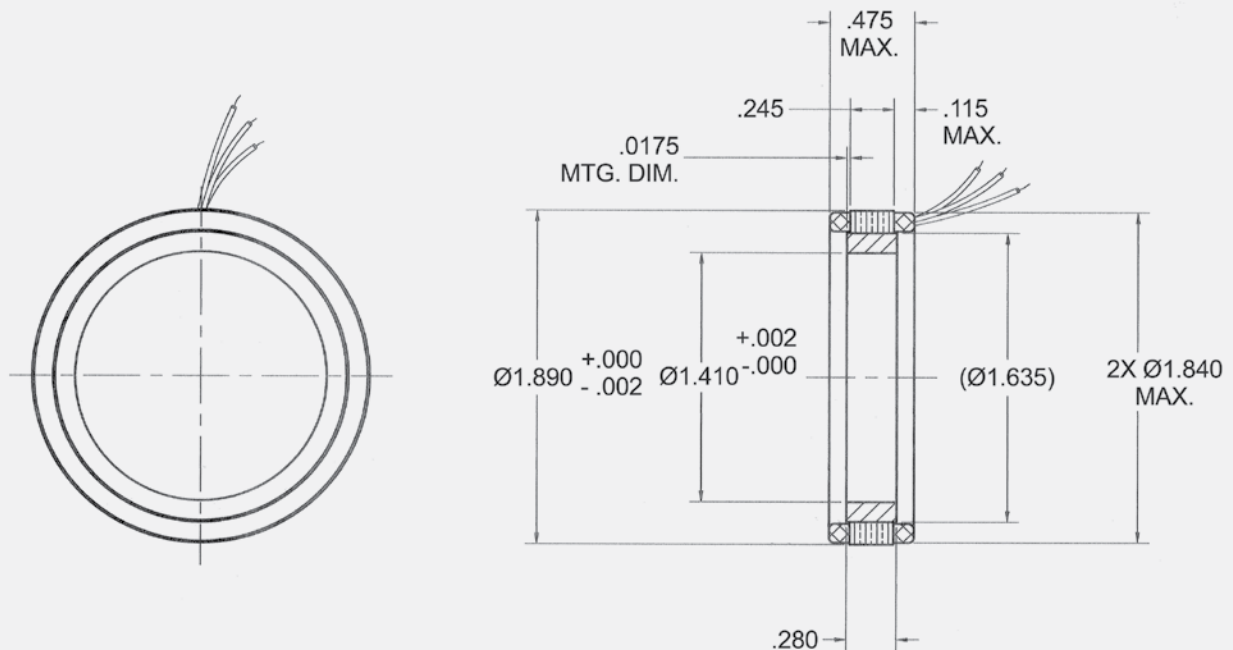
DB-2180-A-1S SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	230
Motor Constant, K_M	oz-in / $\sqrt{W}$	13.9
Number of Poles		16
Number of Phases		3"Y"
Weight	oz (nom)	8
Motor Inertia, J_M	oz-in-s^2	5.00E-03
Friction Torque, T_F	oz-in	4.0
Electrical Time Constant, T_E	ms	0.17
Mechanical Time Constant, T_M	ms	3.65
*Temperature Rise, TPR'	°C / W	5.5
Integral Feedback Device		No

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	19.2
Back EMF, K_E	V per rad/s ± 10%	0.136
Terminal Resistance, R_M	ohms ± 10%	1.90
Terminal Inductance, L_M	mH ± 30%	0.32
Voltage, Stalled at Peak Torque, V_P	volts	22.8
Amps at Peak Torque, I_P	amps	12.0

MECHANICAL DIMENSIONS (INCHES)
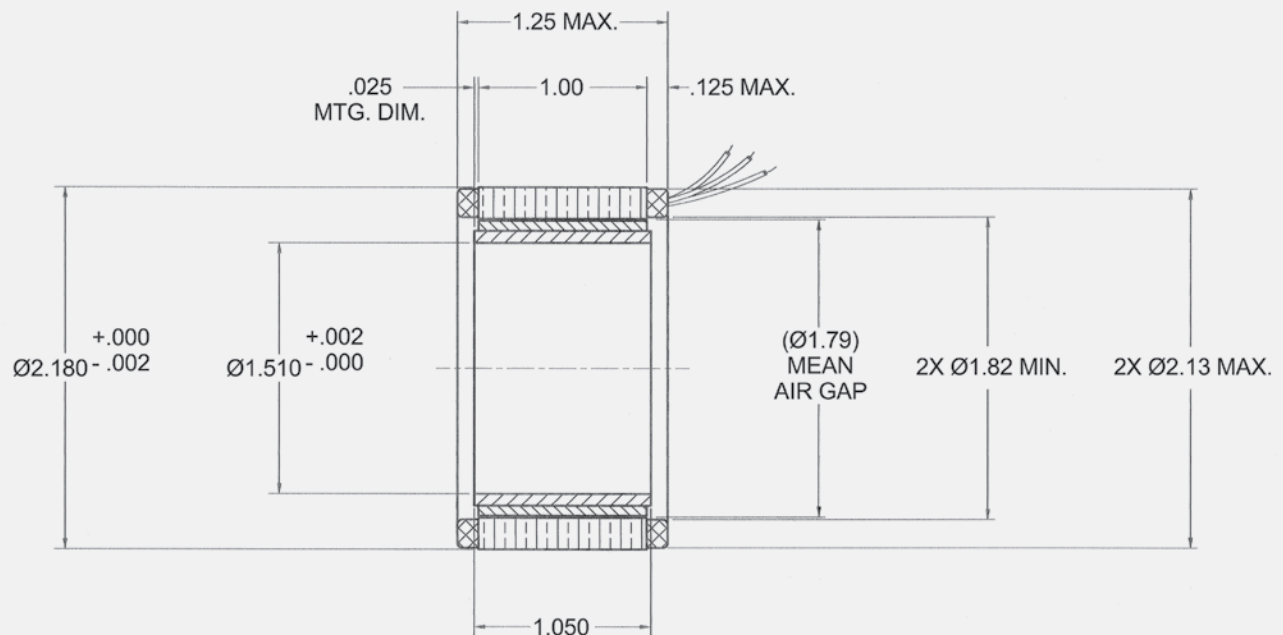
DB-2480-A-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	7.4
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.73
Number of Poles		10
Number of Phases		1 "Y"
Weight	oz (nom)	3.3
Motor Inertia, J_M	oz-in-s^2	2.90E-04
Friction Torque, T_F	oz-in	0.30
Electrical Time Constant, T_E	ms	0.27
Mechanical Time Constant, T_M	ms	5.52
*Temperature Rise, TPR'	°C / W	14.4
Integral Feedback Device		No

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	49.0
Back EMF, K_E	V per rad/s ± 10%	0.346
Terminal Resistance, R_M	ohms ± 10%	323
Terminal Inductance, L_M	mH ± 30%	88
Voltage, Stalled at Peak Torque, V_P	volts	48.5
Amps at Peak Torque, I_P	amps	0.15

MECHANICAL DIMENSIONS (INCHES)
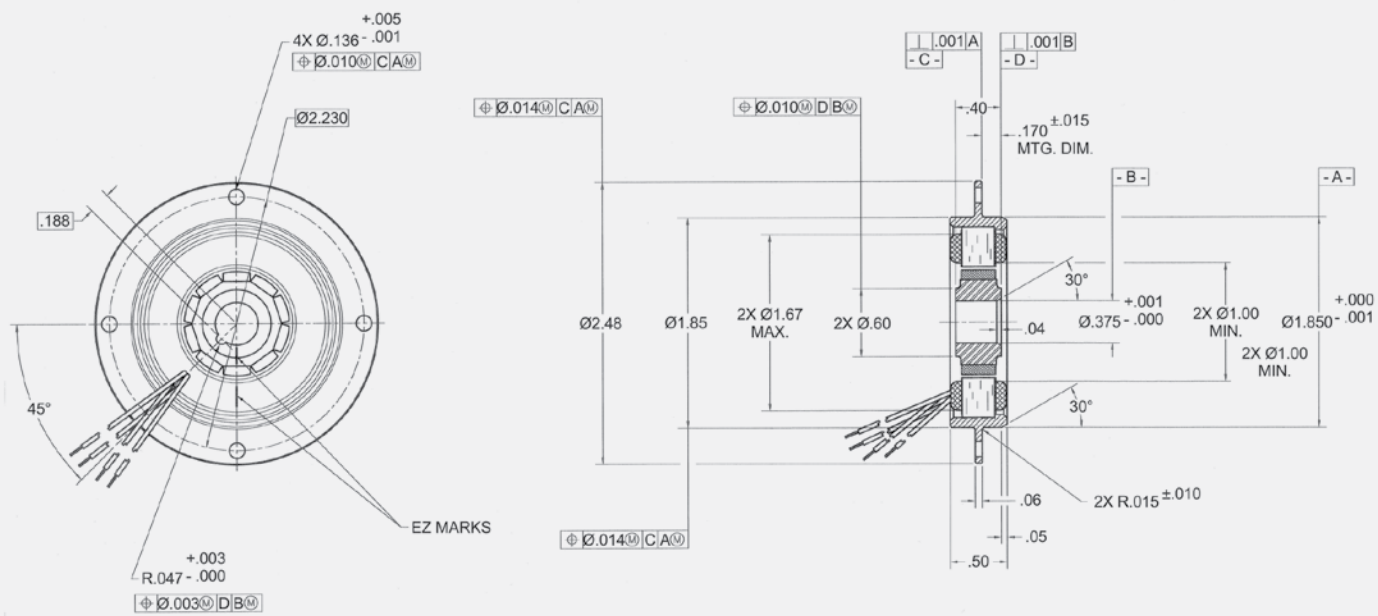
DB-3175-A-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	54
Motor Constant, K_M	oz-in / $\sqrt{W}$	7.38
Number of Poles		16
Number of Phases		2"Y"
Weight	oz (nom)	12
Motor Inertia, J_M	oz-in-s^2	8.30E-03
Friction Torque, T_F	oz-in	1.5
Electrical Time Constant, T_E	ms	0.15
Mechanical Time Constant, T_M	ms	21.60
*Temperature Rise, TPR'	°C / W	7.7
Integral Feedback Device		No

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	68.0
Back EMF, K_E	V per rad/s ± 10%	0.480
Terminal Resistance, R_M	ohms ± 10%	85.0
Terminal Inductance, L_M	mH ± 30%	13
Voltage, Stalled at Peak Torque, V_P	volts	68.0
Amps at Peak Torque, I_P	amps	0.800

MECHANICAL DIMENSIONS (INCHES)

SECTION A - A
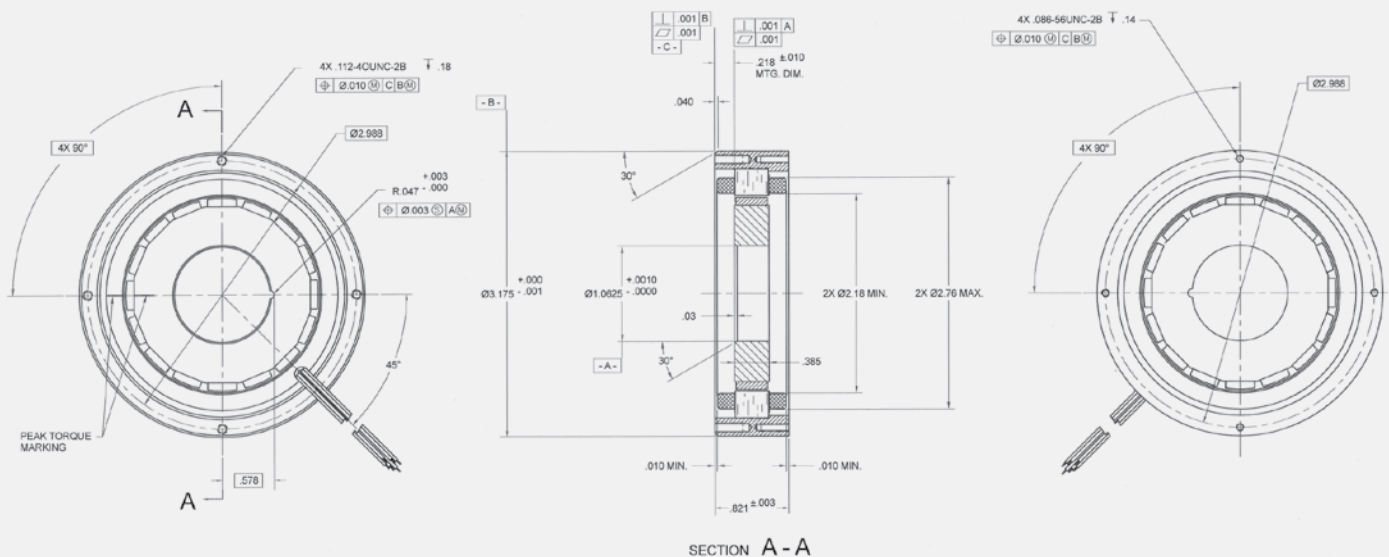
DB-3730-B-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	179
Motor Constant, K_M	oz-in / $\sqrt{W}$	14.9
Number of Poles		10
Number of Phases		1
Weight	oz (nom)	11.3
Motor Inertia, J_M	oz-in-s^2	2.60E-02
Friction Torque, T_F	oz-in	4.5
Electrical Time Constant, T_E	ms	0.33
Mechanical Time Constant, T_M	ms	16.67
*Temperature Rise, TPR'	°C / W	5.9
Integral Feedback Device		No

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	47.0
Back EMF, K_E	V per rad/s ± 10%	0.332
Terminal Resistance, R_M	ohms ± 10%	10.0
Terminal Inductance, L_M	mH ± 30%	3.3
Voltage, Stalled at Peak Torque, V_P	volts	38.1
Amps at Peak Torque, I_P	amps	3.81

MECHANICAL DIMENSIONS (INCHES)
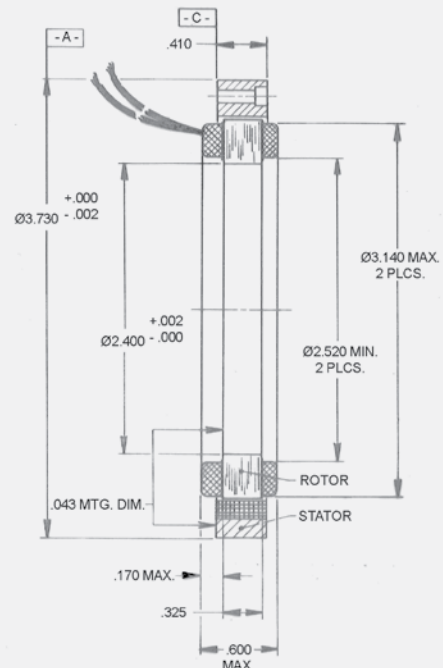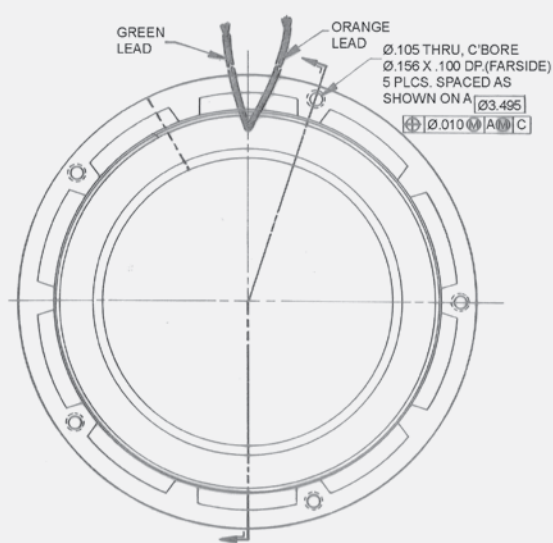
DB-4530-A-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	192.7
Motor Constant, K_M	oz-in / $\sqrt{W}$	16.14
Number of Poles		20
Number of Phases		2
Weight	oz (nom)	17
Motor Inertia, J_M	oz-in-s^2	7.80E-03
Friction Torque, T_F	oz-in	2
Electrical Time Constant, T_E	ms	0.450
Mechanical Time Constant, T_M	ms	4.24
*Temperature Rise, TPR'	°C / W	1.5
Integral Feedback Device		None

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	250
Back EMF, K_E	V per rad/s ± 10%	1.765
Terminal Resistance, R_M	ohms ± 10%	240
Terminal Inductance, L_M	mH ± 30%	108
Voltage, Stalled at Peak Torque, V_P	volts	185
Amps at Peak Torque, I_P	amps	0.77

MECHANICAL DIMENSIONS (INCHES)
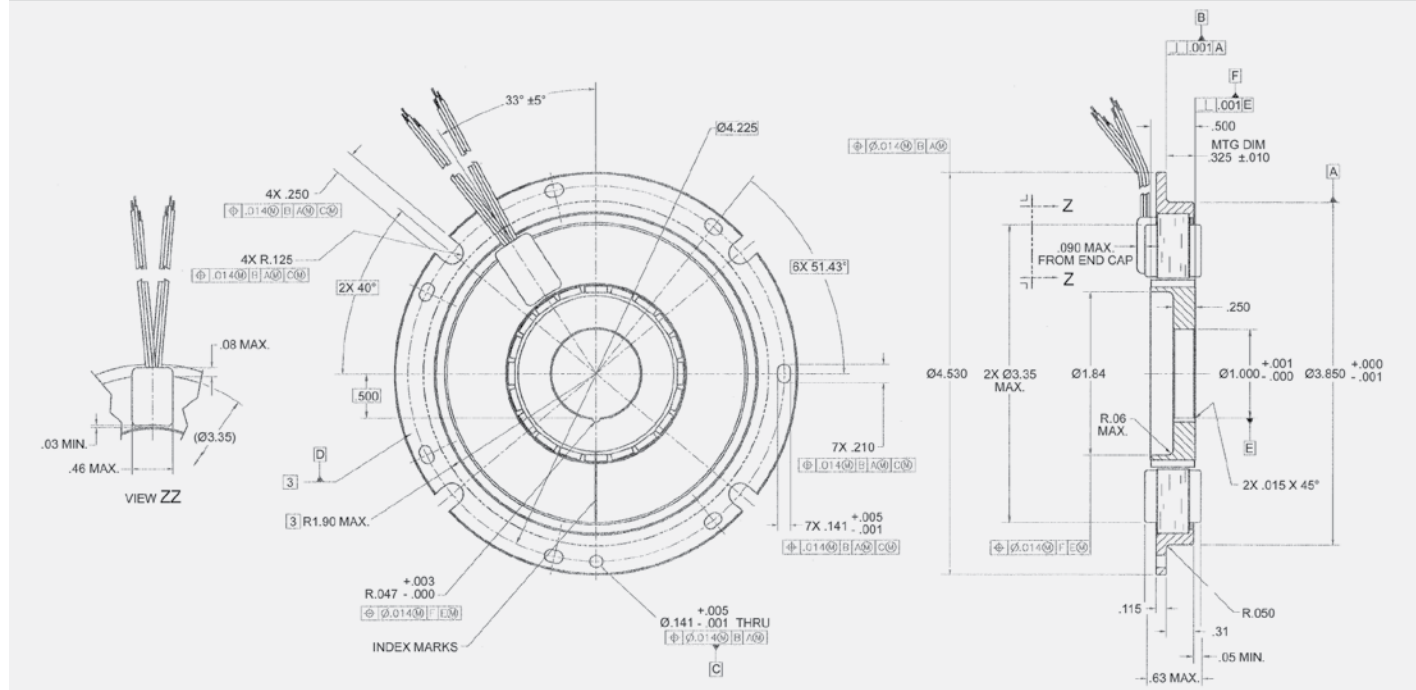
DB-12600-A-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	21248
Motor Constant, K_M	oz-in / $\sqrt{W}$	973
Number of Poles		32
Number of Phases		3"Y"
Weight	oz (nom)	528
Motor Inertia, J_M	oz-in-s^2	7.14
Friction Torque, T_F	oz-in	16
Electrical Time Constant, T_E	ms	6
Mechanical Time Constant, T_M	ms	1.07
*Temperature Rise, TPR'	°C / W	0.43
Integral Feedback Device		No

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp ± 10%	2656
Back EMF, K_E	V per rad/s ± 10%	18.8
Terminal Resistance, R_M	ohms ± 10%	7.45
Terminal Inductance, L_M	mH ± 30%	45
Voltage, Stalled at Peak Torque, V_P	volts	60
Amps at Peak Torque, I_P	amps	8.0

MECHANICAL DIMENSIONS (INCHES)
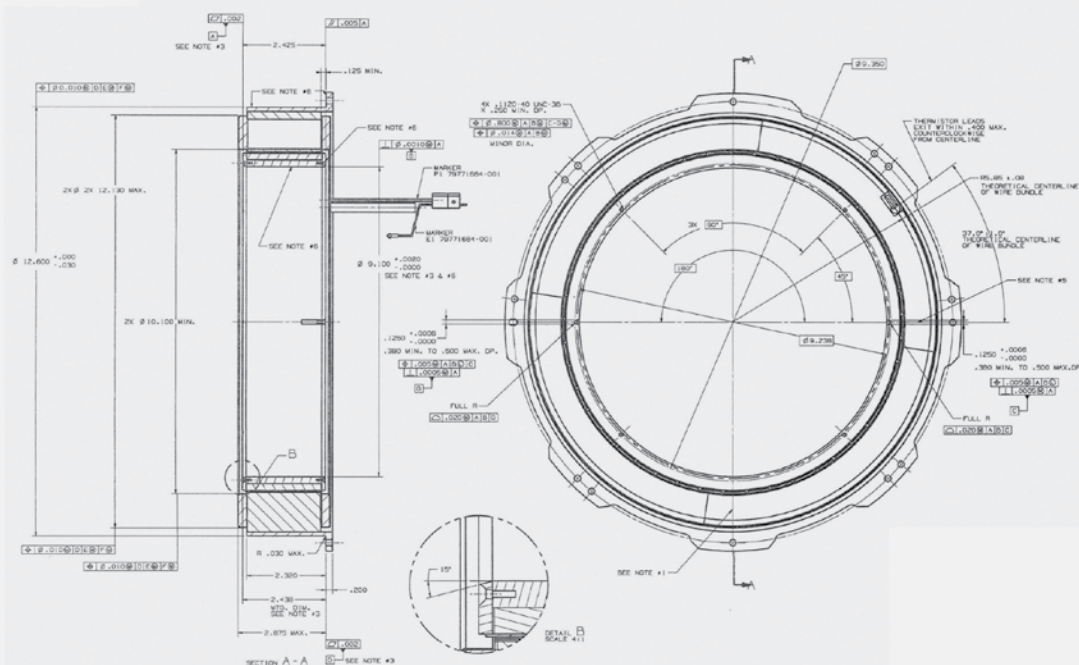
TD SERIES FRAMELESS BRUSHLESS DC LIMITED ANGLE TORQUE MOTORS
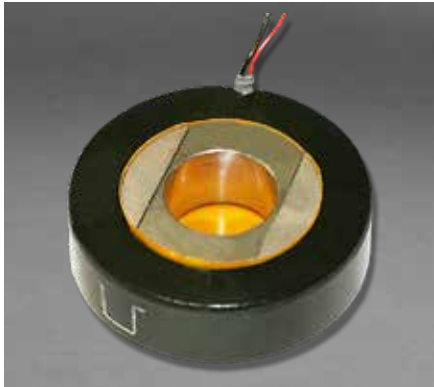
The TD motors are used in applications that require limited angle rotation with a constant torque throughout the excursion angle.

The toroidal motors have the dual advantage of being brushless and providing constant, ripple-free torque sustained through the required angle. Eliminating the slot cogging effect makes toroidal designs desirable in many applications, especially in incremental motion systems and in the field of control instrumentation. In addition, lower rotor inertia motors may be substituted where a high mechanical time constant was incorporated to filter torque ripple.

The motors are supplied as a direct drive rotor / stator frameless part set that is directly attached to the load. This form of attachment eliminates backlash and increases servo stiffness for an optimized direct drive system.

The TD motors consists of a wide range of sizes, outside diameters from 0.6 to over 5 inches (15.24 to 127 mm)

Our engineers design custom solutions. If our existing models don't meet your needs, we will tailor them or provide options for a best value solution to meet your exact requirements.

FEATURES

- Compact
- Peak torques from 1 to over 400 oz-in
  (0.007 to 2.8 N.m)
- Double insulated high temp magnet wire minimizes leakage current and provides good thermal resistance
- Rare earth magnets
- Large through bores

BENEFITS

- Operate over a wide range of speeds - not limited to AC frequency
- Extremely quiet operation with long life capability
- Motor life is not limited to brush or commutator life
- Efficient operation without losses associated with brushes

TYPICAL APPLICATIONS

- Speed and rotation control systems
- Gimbals for FLIR and inertial navigation systems
- Stabilized gun and fire control systems for combat vehicles
- Fire control radars for land and shipboard defense
- Cockpit instrumentation for military and commercial aircraft
- Space and vacuum instruments, actuation systems and momentum wheels
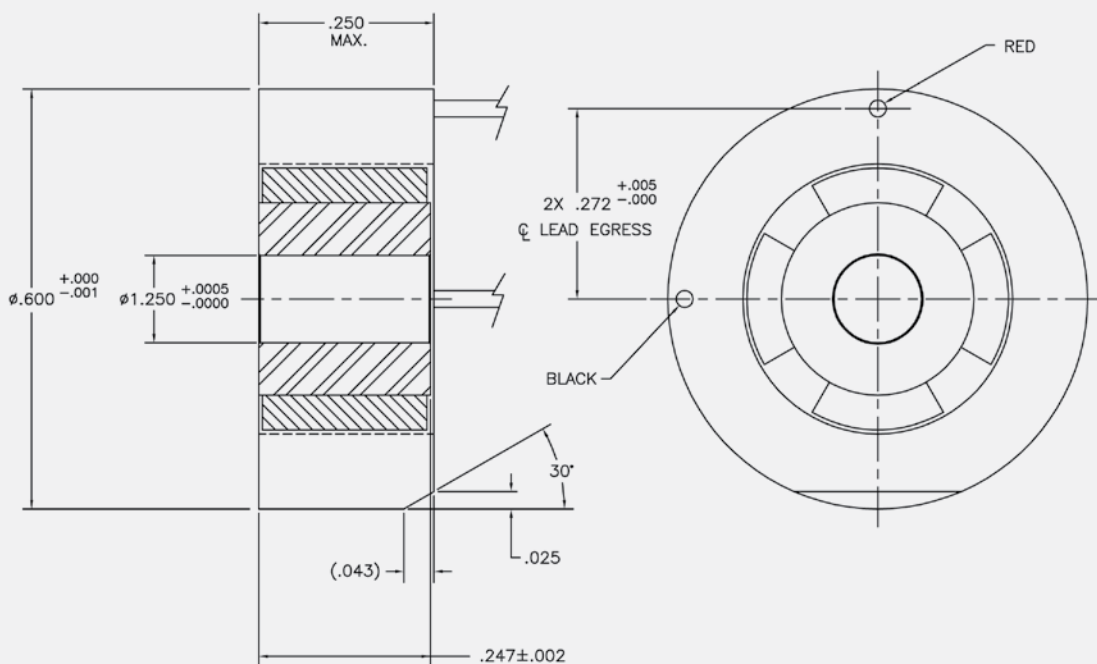
TD-0600-A-15 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	1
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.293
Excursion Angle		± 5
Number of Poles		4
Weight	oz (nom)	0.25
Motor Inertia, J_M	oz-in-s^2	4.69E-06
Friction Torque, T_F	oz-in	0.06
Electrical Time Constant, T_E	ms	0.077
Mechanical Time Constant, T_M	ms	5.37

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	1
Back EMF, K_E	V per rad/s	0.0072
Terminal Resistance, R_M	ohms (nom)	8.25
Terminal Inductance, L_M	mH (nom)	0.634
Voltage, Stalled at Peak Torque, V_P	volts	12
Amps at Peak Torque, I_P	amps	1.5

MECHANICAL DIMENSIONS (INCHES)

TD-1375-D-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	5.5
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.06
Excursion Angle	degrees	± 35
Number of Poles		2
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	2.10E-04
Friction Torque, T_F	oz-in	0.06
Electrical Time Constant, T_E	ms	2.500
Mechanical Time Constant, T_M	ms	23.50

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	3.3
Back EMF, K_E	V per rad/s	0.026
Terminal Resistance, R_M	ohms (nom)	9.6
Terminal Inductance, L_M	mH (nom)	24
Voltage, Stalled at Peak Torque, V_P	volts	20.2
Amps at Peak Torque, I_P	amps	2

MECHANICAL DIMENSIONS (INCHES)
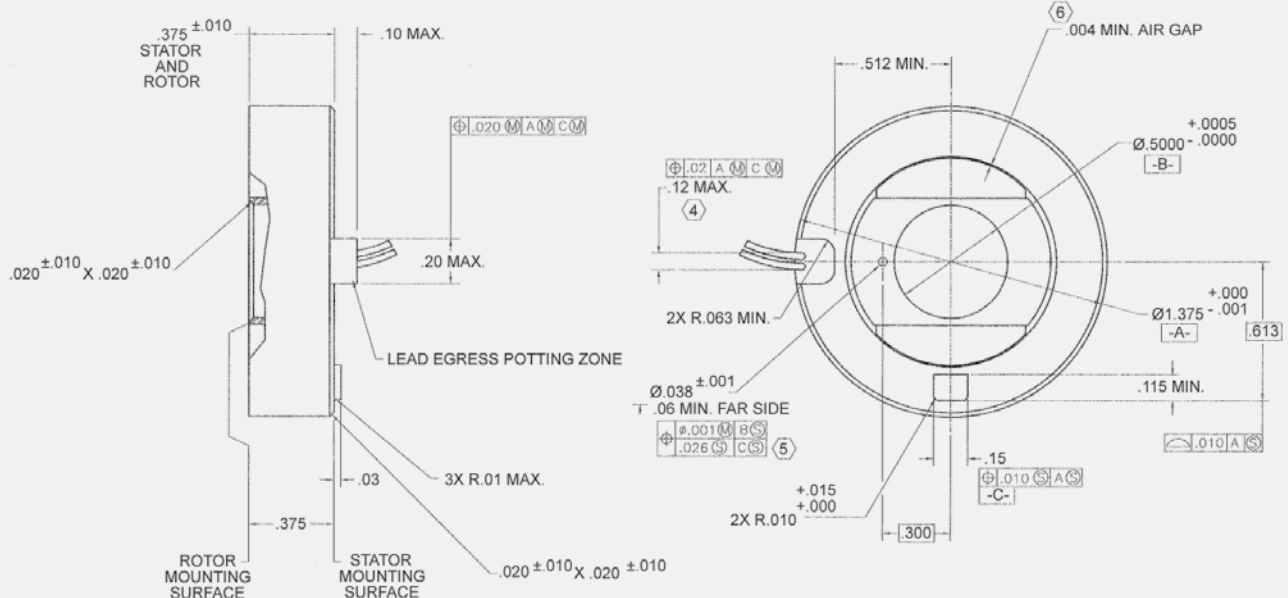
TD-1375-F-1C SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	16.5
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.37
Excursion Angle	degrees	± 28
Number of Poles		4
Weight	oz (nom)	1.5
Motor Inertia, J_M	oz-in-s^2	1.80E-04
Friction Torque, T_F	oz-in	0.08
Electrical Time Constant, T_E	ms	4.5
Mechanical Time Constant, T_M	ms	13.39

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	3.36
Back EMF, K_E	V per rad/s	0.024
Terminal Resistance, R_M	ohms (nom)	6
Terminal Inductance, L_M	mH (nom)	27
Voltage, Stalled at Peak Torque, V_P	volts	34
Amps at Peak Torque, I_P	amps	5.6

MECHANICAL DIMENSIONS (INCHES)
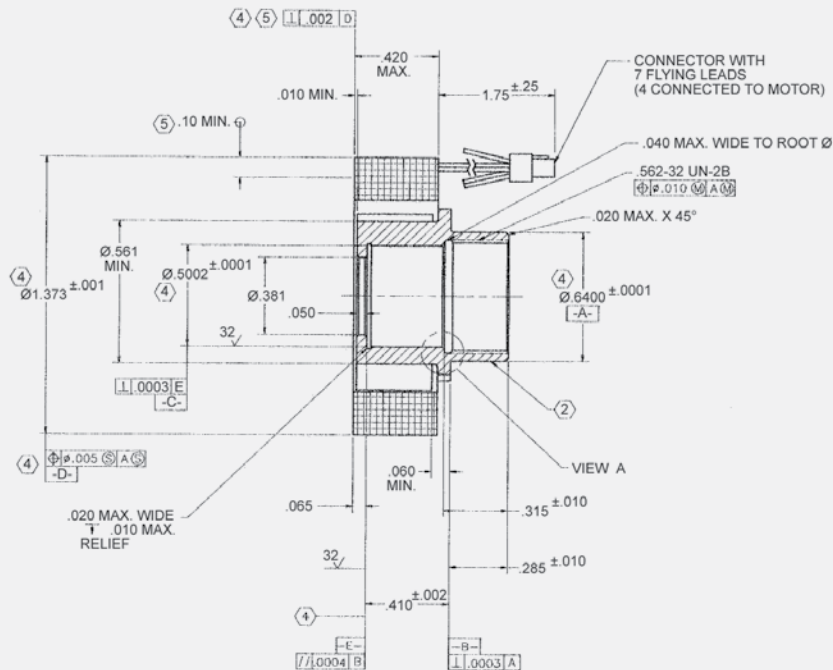
TD-1500-H-1SC SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	22
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.4
Excursion Angle	degrees	± 35
Number of Poles		4
Weight	oz (nom)	2.5
Motor Inertia, J_M	oz-in-s^2	1.55E-04
Friction Torque, T_F	oz-in	0.35
Electrical Time Constant, T_E	ms	0.348
Mechanical Time Constant, T_M	ms	3.81

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	5.75
Back EMF, K_E	V per rad/s	0.0406
Terminal Resistance, R_M	ohms (nom)	5.75
Terminal Inductance, L_M	mH (nom)	2
Voltage, Stalled at Peak Torque, V_P	volts	27
Amps at Peak Torque, I_P	amps	4.25

MECHANICAL DIMENSIONS (INCHES)
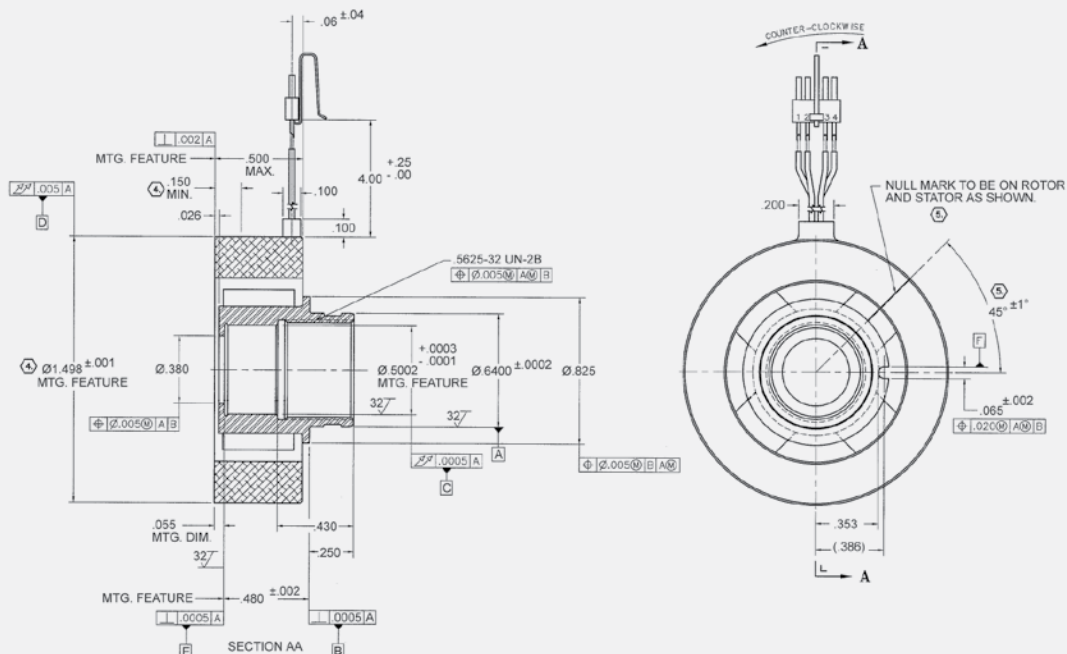
TD-1750-C-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	12
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.48
Excursion Angle	degrees	± 31
Number of Poles		4
Weight	oz (nom)	2.5
Motor Inertia, J_M	oz-in-s^2	6.60E-04
Friction Torque, T_F	oz-in	0.05
Electrical Time Constant, T_E	ms	TBD
Mechanical Time Constant, T_M	ms	36.54

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	4
Back EMF, K_E	V per rad/s	0.028
Terminal Resistance, R_M	ohms (nom)	6.2
Terminal Inductance, L_M	mH (nom)	TBD
Voltage, Stalled at Peak Torque, V_P	volts	19
Amps at Peak Torque, I_P	amps	3

MECHANICAL DIMENSIONS (INCHES)
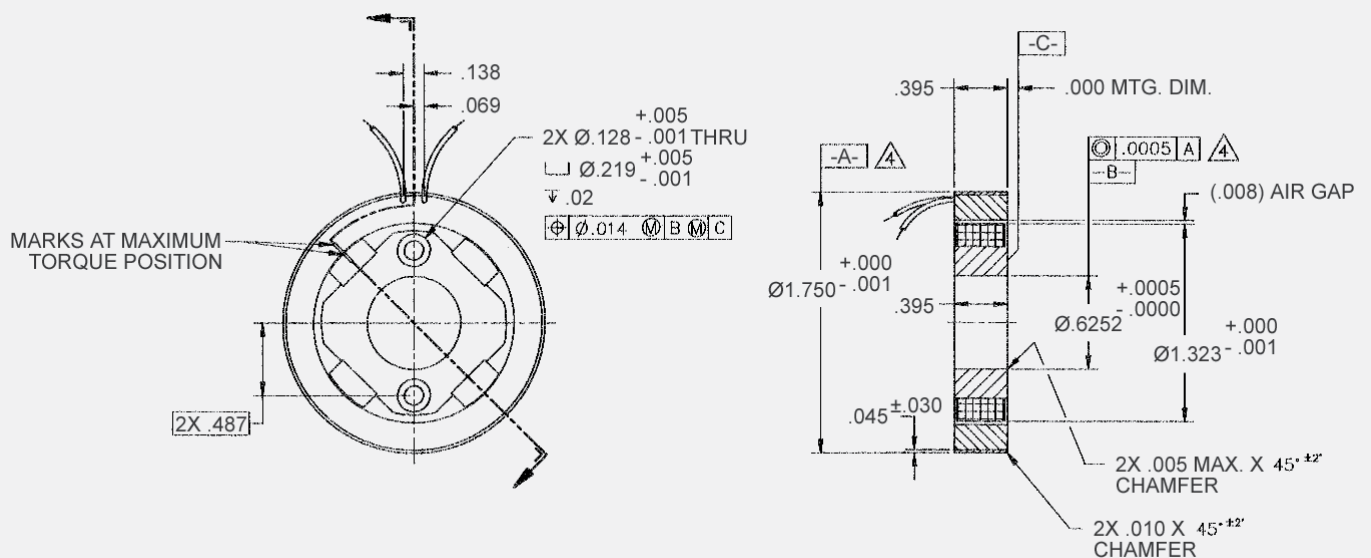
TD-1750-E-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	7.5
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.35
Excursion Angle	degrees	$\pm$ 60
Number of Poles		2
Weight	oz (nom)	5
Motor Inertia, J_M	oz-in-s^2	1.90E-03
Friction Torque, T_F	oz-in	0.3
Electrical Time Constant, T_E	ms	0.529
Mechanical Time Constant, T_M	ms	152

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	2.5
Back EMF, K_E	V per rad/s	0.017
Terminal Resistance, R_M	ohms (nom)	3.4
Terminal Inductance, L_M	mH (nom)	1.8
Voltage, Stalled at Peak Torque, V_P	volts	9
Amps at Peak Torque, I_P	amps	2.5

MECHANICAL DIMENSIONS (INCHES)
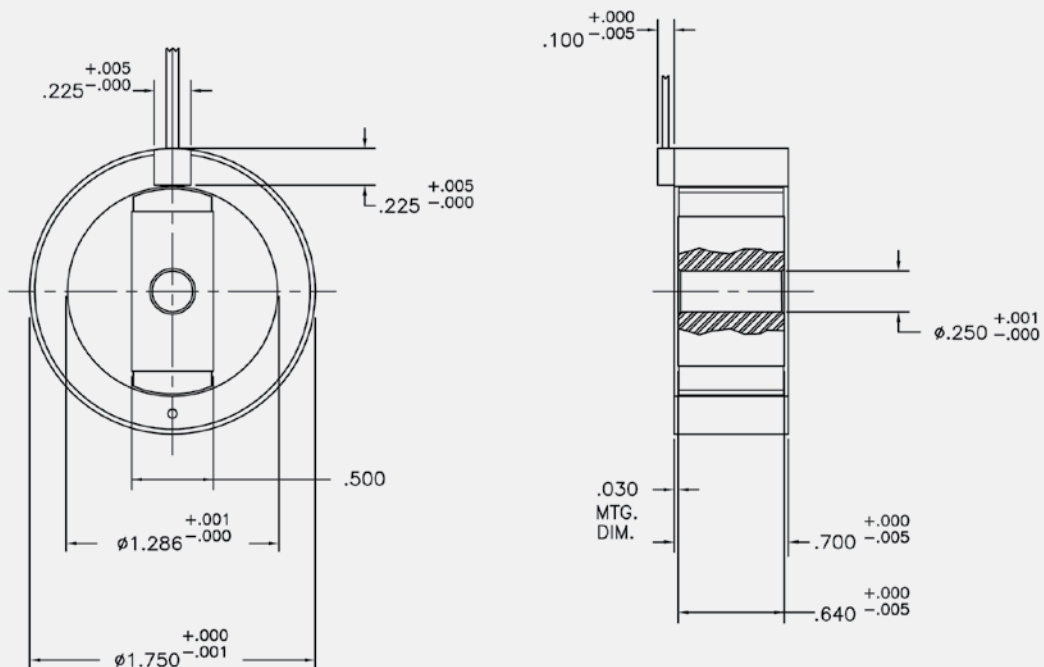
TD-1900-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	18
Motor Constant, K_M	oz-in / $\sqrt{W}$	3.51
Excursion Angle	degrees	± 35
Number of Poles		2
Weight	oz (nom)	10
Motor Inertia, J_M	oz-in-s^2	3.40E-03
Friction Torque, T_F	oz-in	0.5
Electrical Time Constant, T_E	ms	0.625
Mechanical Time Constant, T_M	ms	39.37

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	6.28
Back EMF, K_E	V per rad/s	0.044
Terminal Resistance, R_M	ohms (nom)	3.2
Terminal Inductance, L_M	mH (nom)	2
Voltage, Stalled at Peak Torque, V_P	volts	10
Amps at Peak Torque, I_P	amps	3

MECHANICAL DIMENSIONS (INCHES)
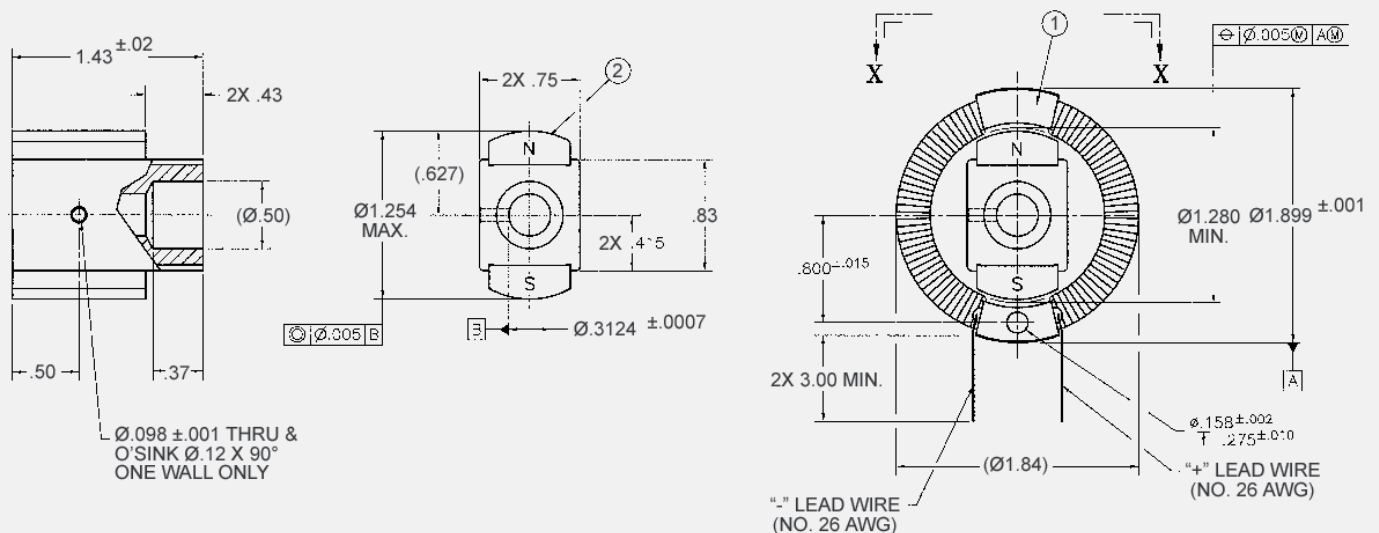
TD-1900-B-1C SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	27
Motor Constant, K_M	oz-in / $\sqrt{W}$	3.53
Excursion Angle	degrees	± 15
Number of Poles		4
Weight	oz (nom)	5.5
Motor Inertia, J_M	oz-in-s^2	2.00E-03
Friction Torque, T_F	oz-in	0.34
Electrical Time Constant, T_E	ms	0.615
Mechanical Time Constant, T_M	ms	22.93

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	9
Back EMF, K_E	V per rad/s	0.063
Terminal Resistance, R_M	ohms (nom)	6.5
Terminal Inductance, L_M	mH (nom)	4
Voltage, Stalled at Peak Torque, V_P	volts	22
Amps at Peak Torque, I_P	amps	3

MECHANICAL DIMENSIONS (INCHES)
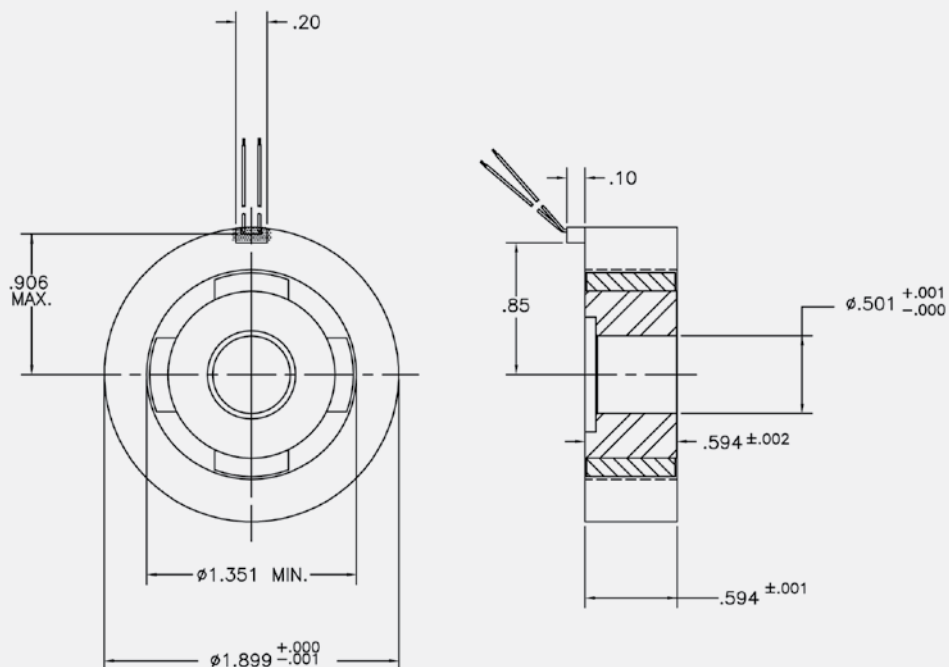
TD-2250-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	18.8
Motor Constant, K_M	oz-in / $\sqrt{W}$	4.77
Excursion Angle	degrees	± 7.5
Number of Poles		4
Weight	oz (nom)	7.5
Motor Inertia, J_M	oz-in-s^2	2.26E-03
Friction Torque, T_F	oz-in	0.5
Electrical Time Constant, T_E	ms	26.866
Mechanical Time Constant, T_M	ms	0.20

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	33
Back EMF, K_E	V per rad/s	0.233
Terminal Resistance, R_M	ohms (nom)	0.67
Terminal Inductance, L_M	mH (nom)	18
Voltage, Stalled at Peak Torque, V_P	volts	24
Amps at Peak Torque, I_P	amps	0.648

MECHANICAL DIMENSIONS (INCHES)

SECTION Y-Y

INDEX MARK ON ROTOR & STATOR TO INDICATE MAX. SENSITIVITY

±5°
45°

+.000
- .005
.625
.500
.062 MTG. DIM.
+.000
- .001
Ø2.250
+.000
- .000
Ø.5000
-A-

SECTION Z-Z
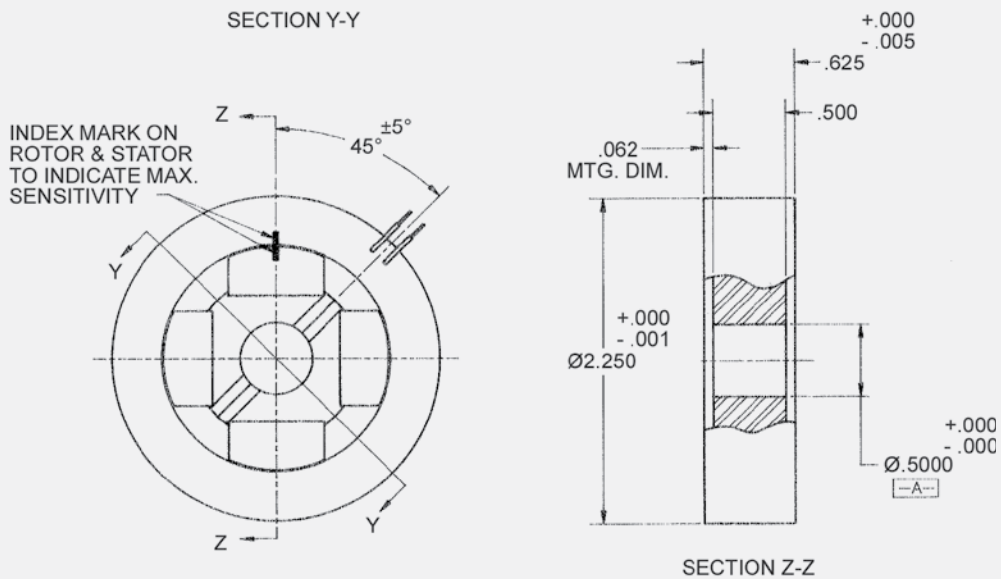
TD-2300-A-1S SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	10.5
Motor Constant, K_M	oz-in / $\sqrt{W}$	3.2
Excursion Angle	degrees	± 23
Number of Poles		4
Weight	oz (nom)	7
Motor Inertia, J_M	oz-in-s^2	3.80E-03
Friction Torque, T_F	oz-in	0.35
Electrical Time Constant, T_E	ms	0.357
Mechanical Time Constant, T_M	ms	52.16

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	12
Back EMF, K_E	V per rad/s	0.085
Terminal Resistance, R_M	ohms (nom)	14
Terminal Inductance, L_M	mH (nom)	5
Voltage, Stalled at Peak Torque, V_P	volts	14
Amps at Peak Torque, I_P	amps	1

MECHANICAL DIMENSIONS (INCHES)
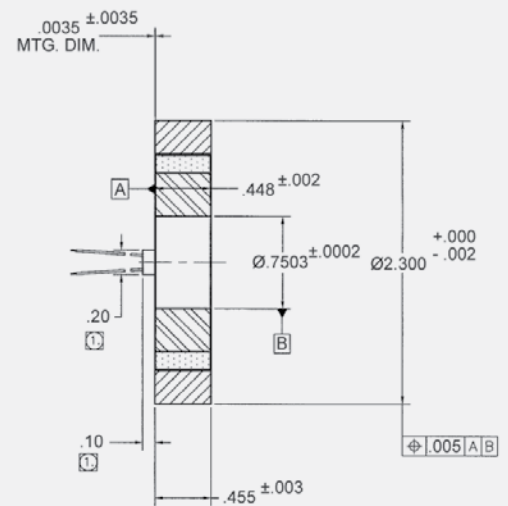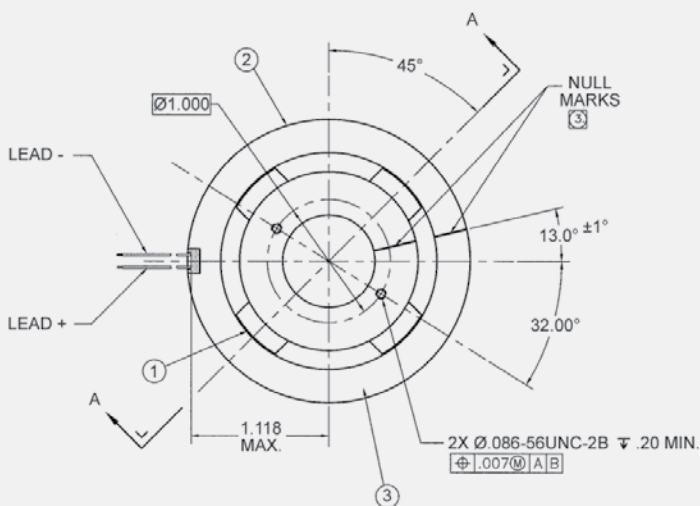
TD-2380-A-1S SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	12.5
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.04
Excursion Angle	degrees	± 8
Number of Poles		4
Weight	oz (nom)	3.5
Motor Inertia, J_M	oz-in-s^2	1.78E-03
Friction Torque, T_F	oz-in	0.35
Electrical Time Constant, T_E	ms	0.500
Mechanical Time Constant, T_M	ms	6.10

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	5
Back EMF, K_E	V per rad/s	0.35
Terminal Resistance, R_M	ohms (nom)	6
Terminal Inductance, L_M	mH (nom)	3
Voltage, Stalled at Peak Torque, V_P	volts	15
Amps at Peak Torque, I_P	amps	2.5

MECHANICAL DIMENSIONS (INCHES)
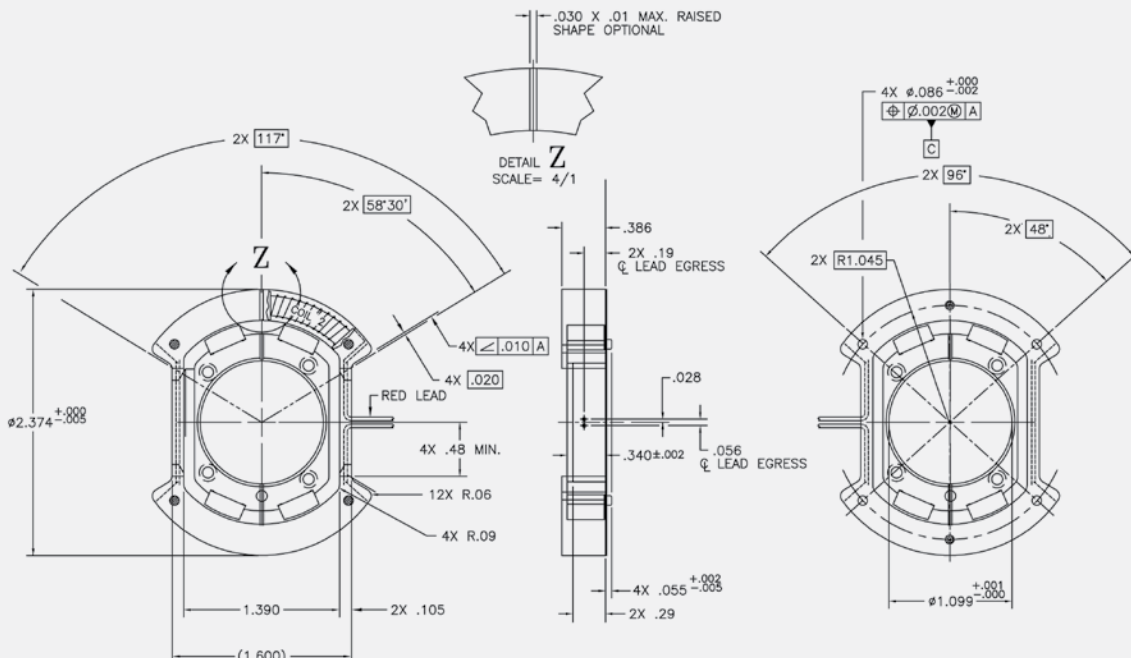
TD-2500-F-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	18
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.35
Excursion Angle	degrees	± 60
Number of Poles		2
Weight	oz (nom)	6.5
Motor Inertia, J_M	oz-in-s^2	2.30E-03
Friction Torque, T_F	oz-in	0.3
Electrical Time Constant, T_E	ms	TBD
Mechanical Time Constant, T_M	ms	58.90

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	5.9
Back EMF, K_E	V per rad/s	0.0417
Terminal Resistance, R_M	ohms (nom)	6.3
Terminal Inductance, L_M	mH (nom)	TBD
Voltage, Stalled at Peak Torque, V_P	volts	20
Amps at Peak Torque, I_P	amps	3.17

MECHANICAL DIMENSIONS (INCHES)

51
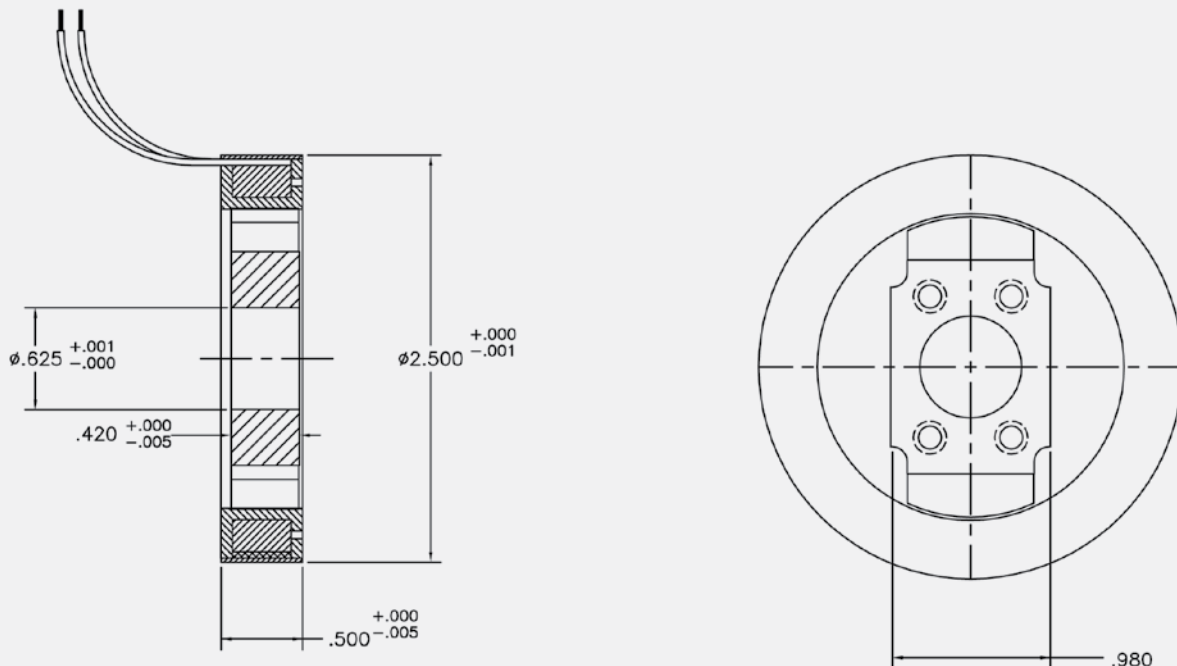
TD-3182-A-2S SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	20
Motor Constant, K_M	oz-in / $\sqrt{W}$	3.17
Excursion Angle	degrees	± 6
Number of Poles		4
Weight	oz (nom)	8.5
Motor Inertia, J_M	oz-in-s^2	6.00E-03
Friction Torque, T_F	oz-in	0.2
Electrical Time Constant, T_E	ms	0.656
Mechanical Time Constant, T_M	ms	84.46

MOTOR WINDING CONSTANTS

Specification	Units	Value
**Torque Sensitivity, K_T	oz-in/amp	22
Back EMF, K_E	V per rad/s	0.155
Terminal Resistance, R_M	ohms (nom)	48
Terminal Inductance, L_M	mH (nom)	31.5
Voltage, Stalled at Peak Torque, V_P	volts	95
Amps at Peak Torque, I_P	amps	1.0

MECHANICAL DIMENSIONS (INCHES)
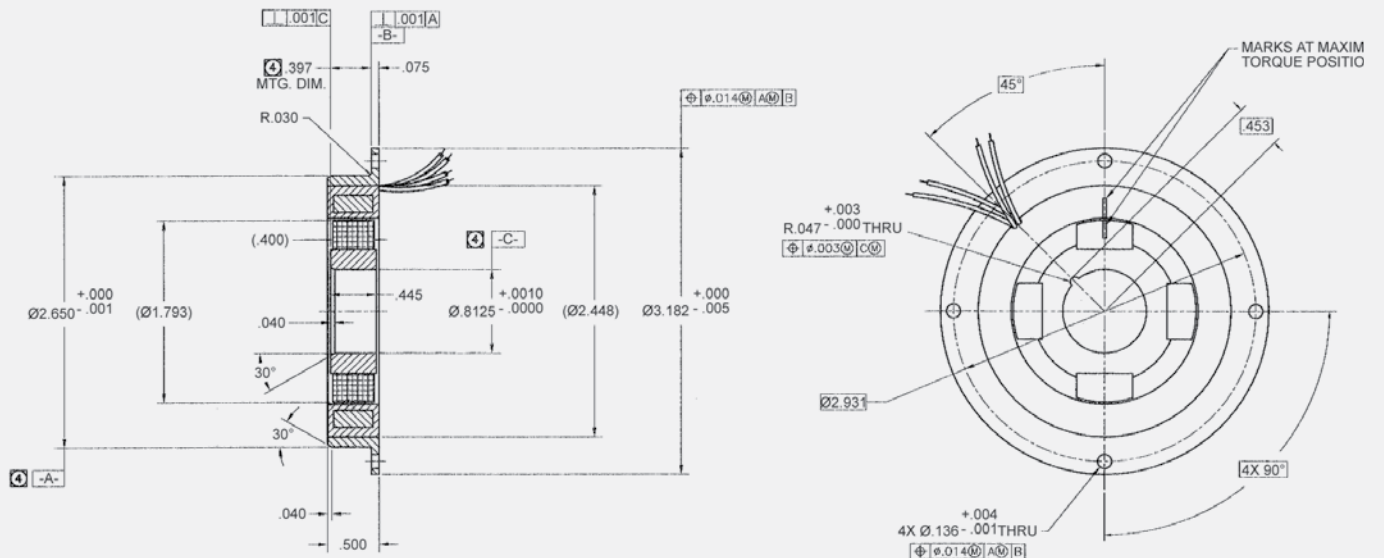
TD-3300-J-1SC SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	25
Motor Constant, K_M	oz-in / $\sqrt{W}$	6.82
Excursion Angle	degrees	± 22.5
Number of Poles		4
Weight	oz (nom)	11
Motor Inertia, J_M	oz-in-s^2	1.49E-02
Friction Torque, T_F	oz-in	1
Electrical Time Constant, T_E	ms	1.144
Mechanical Time Constant, T_M	ms	45.15

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	22
Back EMF, K_E	V per rad/s	0.156
Terminal Resistance, R_M	ohms (nom)	10.4
Terminal Inductance, L_M	mH (nom)	11.9
Voltage, Stalled at Peak Torque, V_P	volts	24
Amps at Peak Torque, I_P	amps	1.14

MECHANICAL DIMENSIONS (INCHES)

SHOWN ORIENTED AT ZERO DEGREES ANGULAR TRAVEL
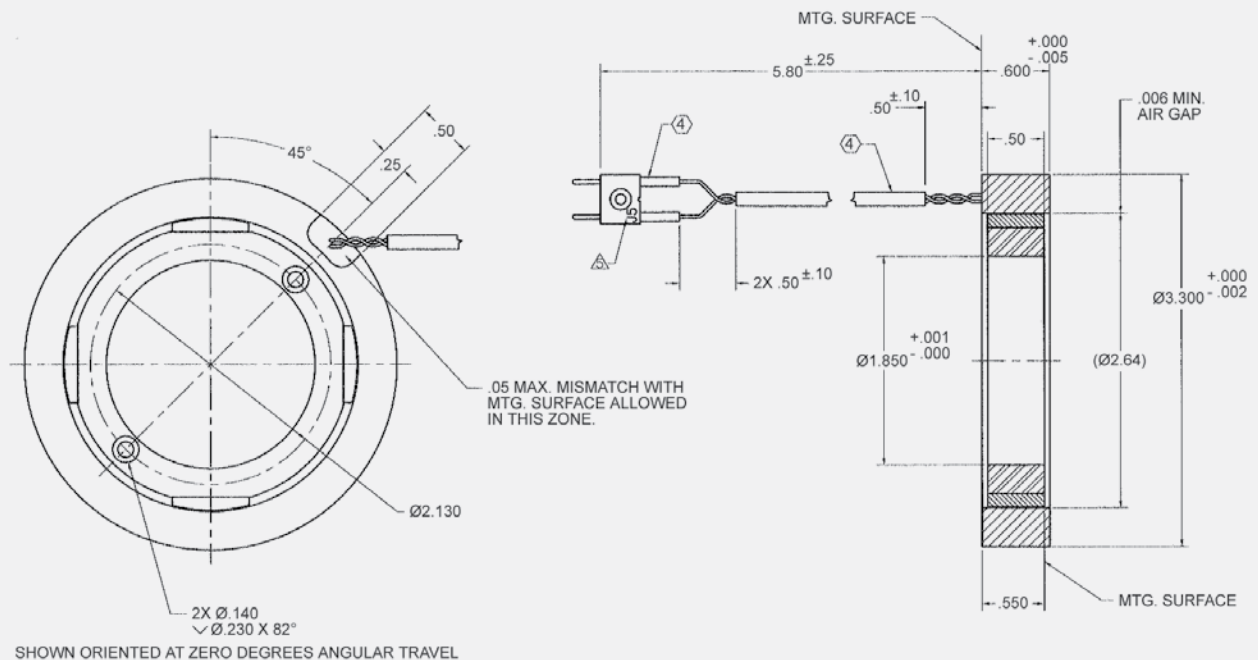
TD-3300-K-1SC SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	65
Motor Constant, K_M	oz-in / $\sqrt{W}$	13.34
Excursion Angle	degrees	± 22.5
Number of Poles		4
Weight	oz (nom)	23.2
Motor Inertia, J_M	oz-in-s^2	3.10E-02
Friction Torque, T_F	oz-in	1
Electrical Time Constant, T_E	ms	TBD
Mechanical Time Constant, T_M	ms	24.62

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	26
Back EMF, K_E	V per rad/s	0.184
Terminal Resistance, R_M	ohms (nom)	3.8
Terminal Inductance, L_M	mH (nom)	TBD
Voltage, Stalled at Peak Torque, V_P	volts	12
Amps at Peak Torque, I_P	amps	3.16

MECHANICAL DIMENSIONS (INCHES)

ORIENTED AT ZERO DEGREES ANGULAR TRAVEL
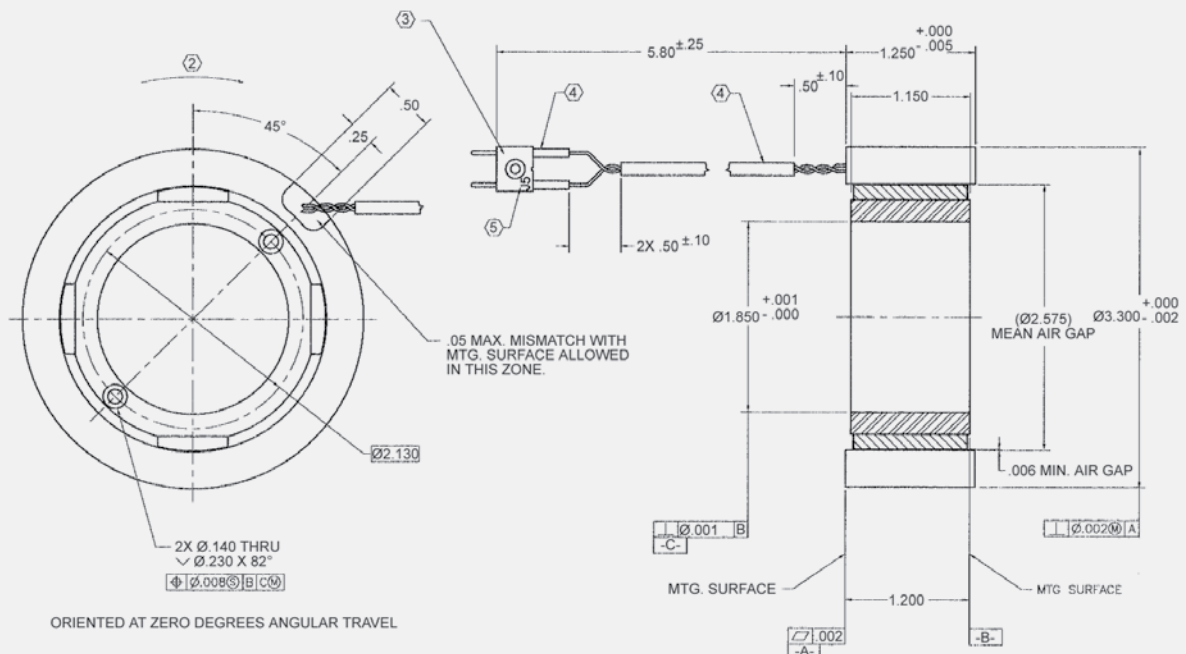
TD-4094-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	144
Motor Constant, K_M	oz-in / $\sqrt{W}$	21.5
Excursion Angle	degrees	± 15
Number of Poles		6
Weight	oz (nom)	24
Motor Inertia, J_M	oz-in-s^2	7.60E-02
Friction Torque, T_F	oz-in	0.75
Electrical Time Constant, T_E	ms	0.520
Mechanical Time Constant, T_M	ms	23.42

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	48
Back EMF, K_E	V per rad/s	0.338
Terminal Resistance, R_M	ohms (nom)	5
Terminal Inductance, L_M	mH (nom)	2.6
Voltage, Stalled at Peak Torque, V_P	volts	28
Amps at Peak Torque, I_P	amps	3

MECHANICAL DIMENSIONS (INCHES)
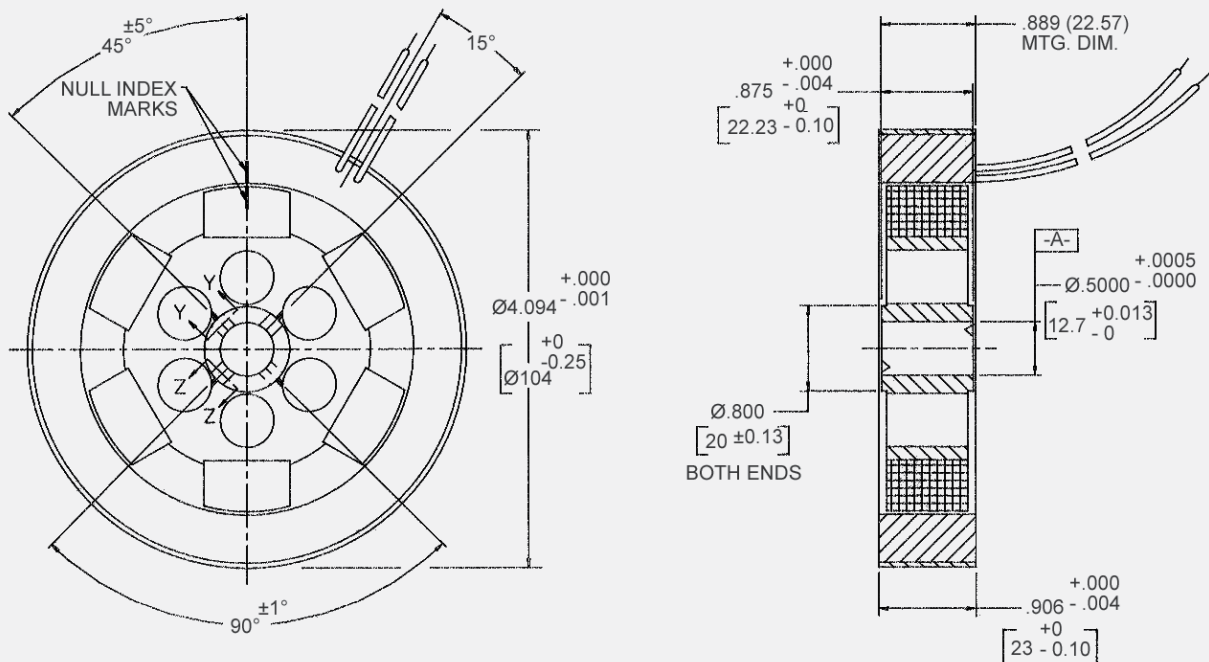
TD-4180-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	336
Motor Constant, K_M	oz-in / $\sqrt{W}$	26.5
Excursion Angle	degrees	± 10
Number of Poles		6
Weight	oz (nom)	48
Motor Inertia, J_M	oz-in-s^2	6.8E-02
Friction Torque, T_F	oz-in	0.1
Electrical Time Constant, T_E	ms	2.000
Mechanical Time Constant, T_M	ms	13.75

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	73
Back EMF, K_E	V per rad/s	.515
Terminal Resistance, R_M	ohms (nom)	7.6
Terminal Inductance, L_M	mH (nom)	14
Voltage, Stalled at Peak Torque, V_P	volts	14
Amps at Peak Torque, I_P	amps	2

MECHANICAL DIMENSIONS (INCHES)
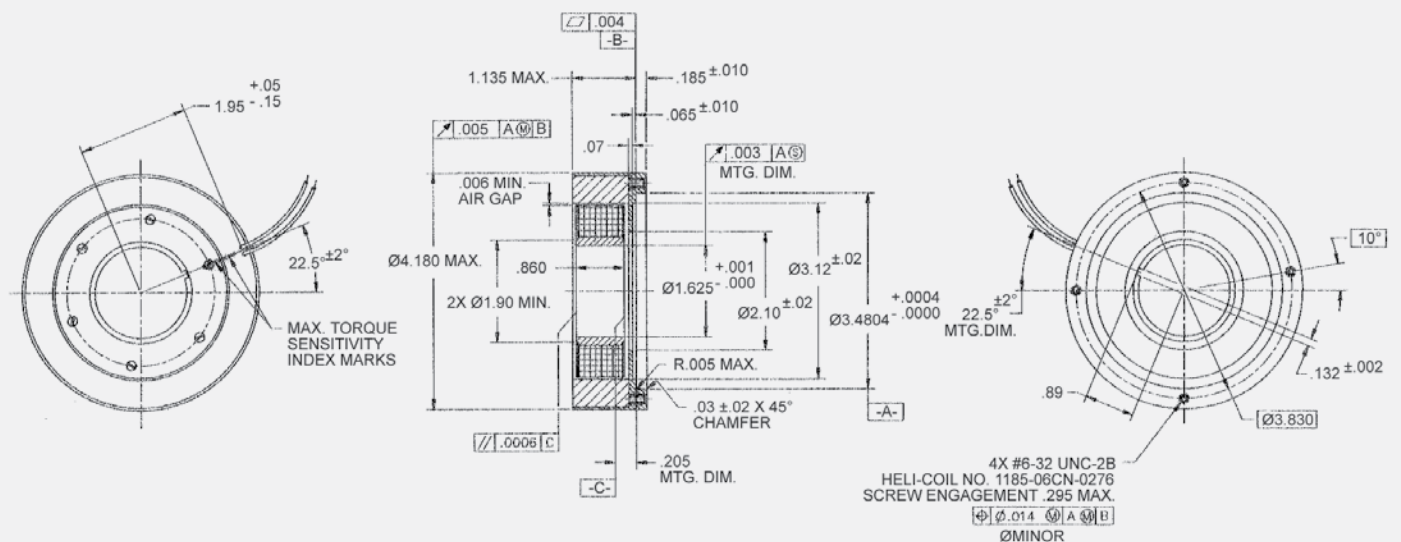
TD-4580-B-2S / K059 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	120
Motor Constant, K_M	oz-in / $\sqrt{W}$	33.17
Excursion Angle	degrees	± 5
Number of Poles		6
Weight	oz (nom)	30.5
Motor Inertia, J_M	oz-in-s^2	3.20E-02
Friction Torque, T_F	oz-in	6
Electrical Time Constant, T_E	ms	1.364
Mechanical Time Constant, T_M	ms	4.12

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	110
Back EMF, K_E	V per rad/s	0.777
Terminal Resistance, R_M	ohms (nom)	11
Terminal Inductance, L_M	mH (nom)	15
Voltage, Stalled at Peak Torque, V_P	volts	17
Amps at Peak Torque, I_P	amps	1.55

MECHANICAL DIMENSIONS (INCHES)
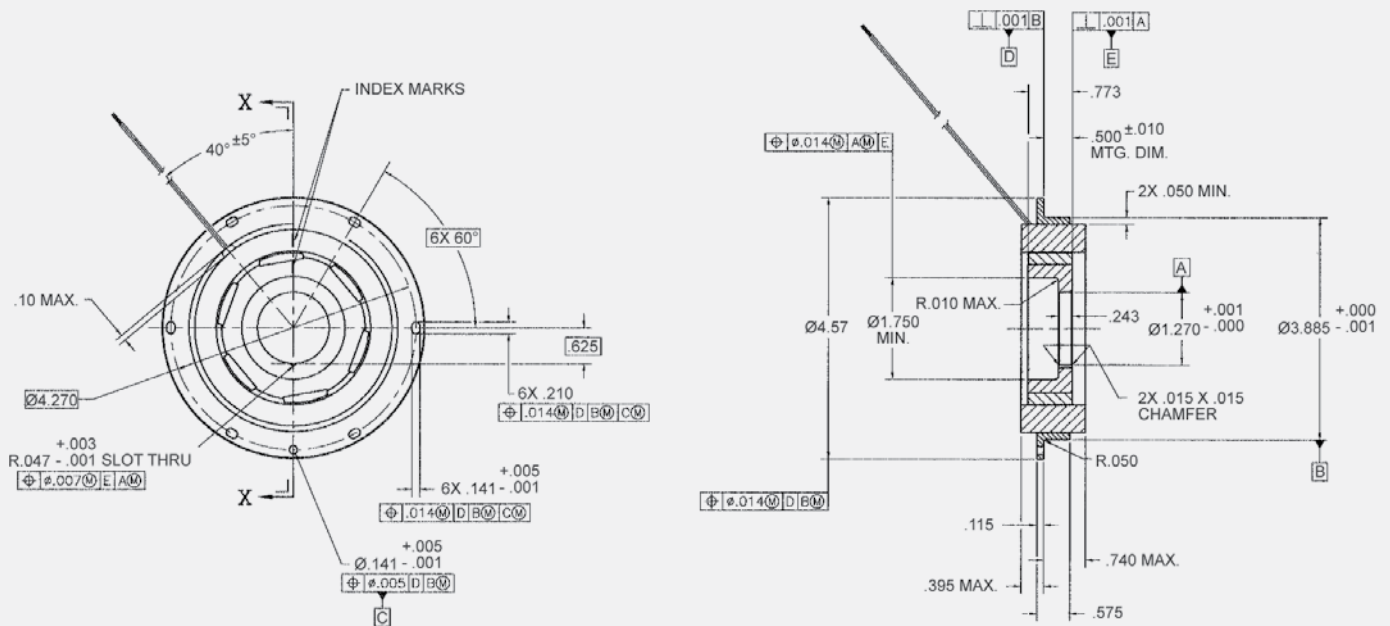
TD-4882-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	350
Motor Constant, K_M	oz-in / $\sqrt{W}$	23.3
Excursion Angle	degrees	± 15
Number of Poles		6
Weight	oz (nom)	41.3
Motor Inertia, J_M	oz-in-s^2	8.30E-02
Friction Torque, T_F	oz-in	0.75
Electrical Time Constant, T_E	ms	2.300
Mechanical Time Constant, T_M	ms	21.69

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	52
Back EMF, K_E	V per rad/s	0.368
Terminal Resistance, R_M	ohms (nom)	5
Terminal Inductance, L_M	mH (nom)	11.5
Voltage, Stalled at Peak Torque, V_P	volts	34
Amps at Peak Torque, I_P	amps	6.73

MECHANICAL DIMENSIONS (INCHES)
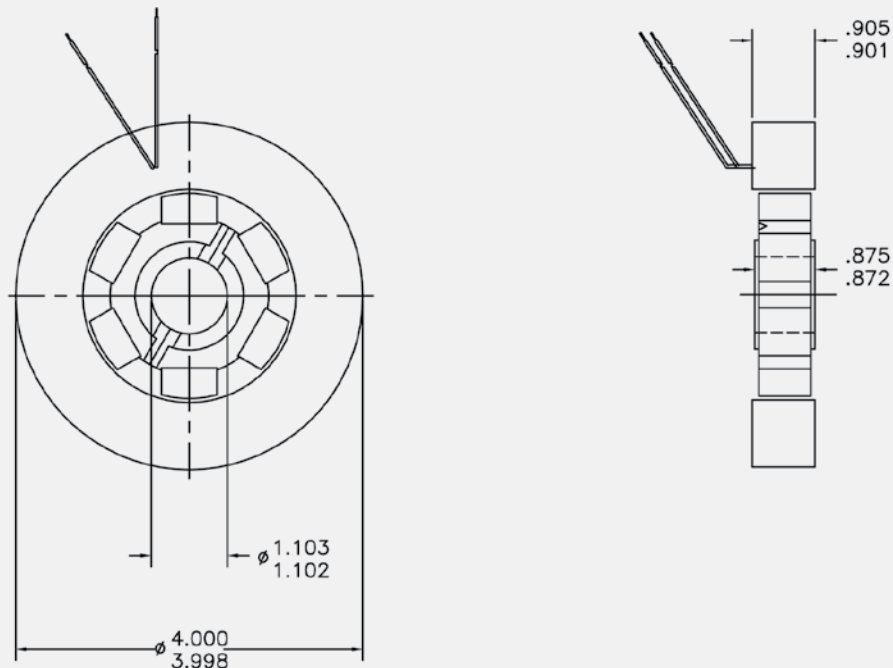
# TD-4960-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	120
Motor Constant, K_M	oz-in / $\sqrt{W}$	35
Excursion Angle	degrees	± 15
Number of Poles		6
Weight	oz (nom)	24
Motor Inertia, J_M	oz-in-s^2	1.19E-01
Friction Torque, T_F	oz-in	0.75
Electrical Time Constant, T_E	ms	0.455
Mechanical Time Constant, T_M	ms	13.76

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in/amp	82
Back EMF, K_E	V per rad/s	0.58
Terminal Resistance, R_M	ohms (nom)	5.5
Terminal Inductance, L_M	mH (nom)	2.5
Voltage, Stalled at Peak Torque, V_P	volts	18
Amps at Peak Torque, I_P	amps	1.46

MECHANICAL DIMENSIONS (INCHES)
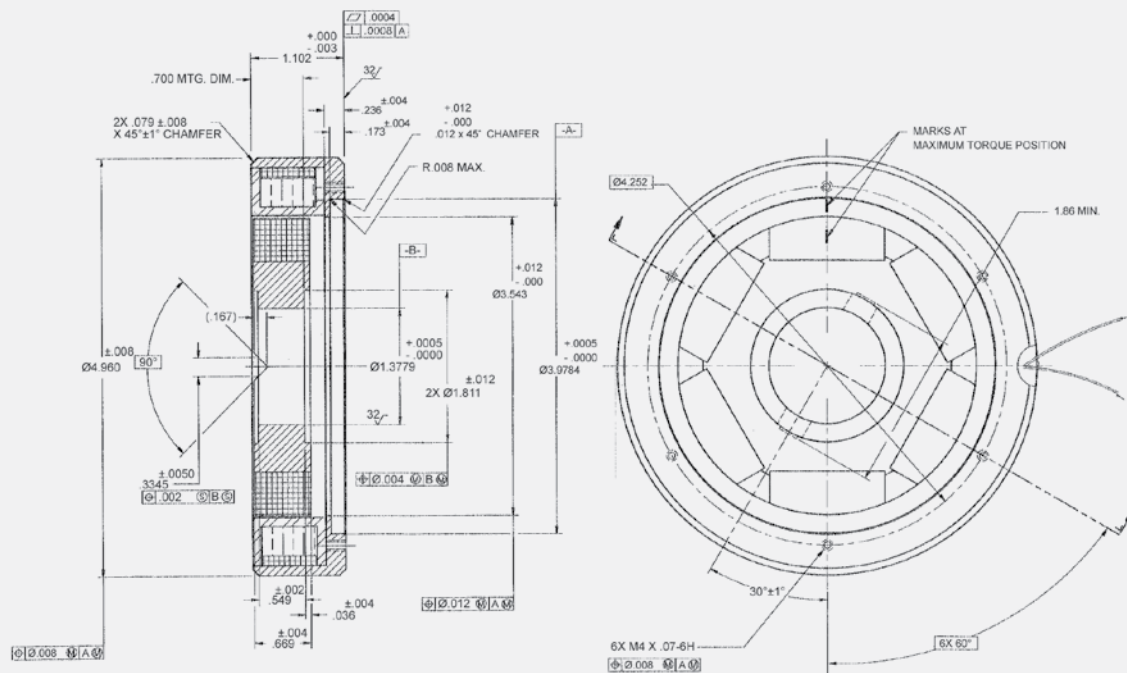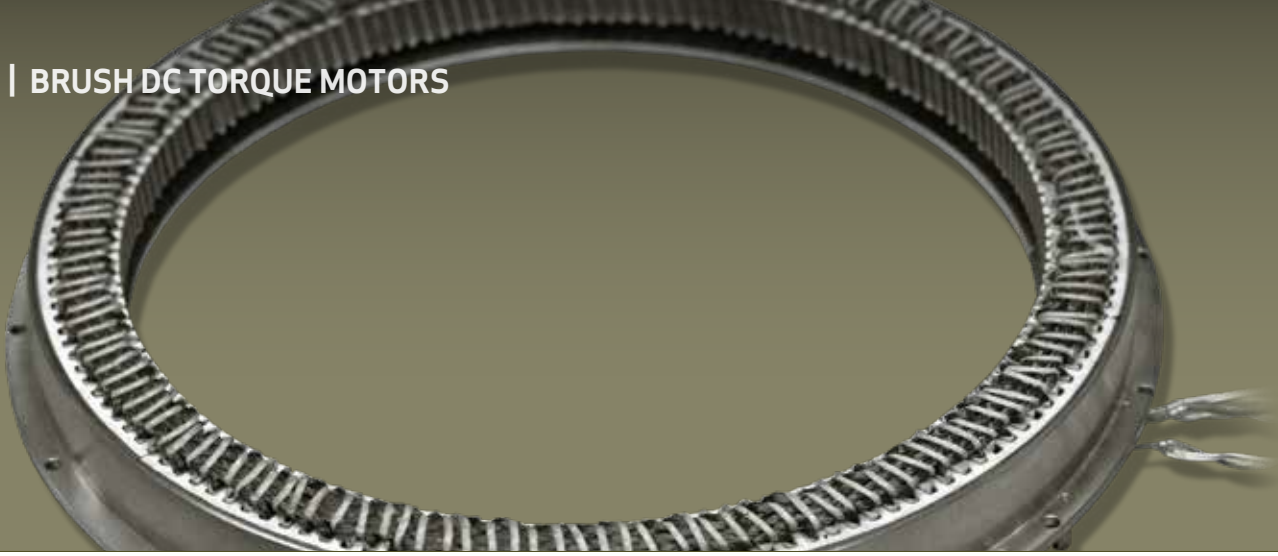
BRUSH DC TORQUE MOTORS

Moog designs and manufactures precision motion technology components and subsystems for defense, aerospace and industrial applications.

Our specialty DC brush torque and servomotors can be supplied housed with a variety of shaft configurations but typically as a direct drive rotor / stator part-set that will be directly attached to the load. This form of attachment eliminates backlash and increases servo stiffness for an optimized direct drive system.

DC torque motors are used in applications that require high torque at slow speeds with input power minimized. Our DC servomotors are used in applications that require high speed and positional accuracy. Custom controllers can be supplied on a design-to-specification basis.

FEATURES

- Double insulated high temp magnet wire minimizes leakage current, promotes superior insulation
- Molded brush block assembly features interchangeable brush blocks, optimizing brush position on commutator. Brush contour is done on automatic tooling rather than "run-in" individually.
- Brushes mechanically fastened to brush spring in addition to soldering assures brush alignment during soldering operation plus proper mechanical and electrical bond between brush spring and brush.
- Stable high temp encapsulation material minimizes movement or working of windings under large temperature variations. This high temp material will not crack under temperature variations, and eliminates voids, exposed windings and humidity traps.
- Special magnetic material alloy allows higher torque per unit of volume, higher torque to inertia ratio.
- Plated magnet assemblies resist environmental extremes and require no special handling

- Rare earth magnets typical
- High torque and low speed
- High torque to inertia ratio
- Low speed with high accuracy
- Compact
- Large axial holes through armature for easy application to shafts and bosses

TYPICAL APPLICATIONS

- Speed and rotation control systems
- Gimbals for FLIR and inertial navigation systems
- Stabilized gun and fire control systems for combat vehicles
- Fire control radars for land and shipboard defense
- Cockpit instrumentation for military and commercial aircraft
- Space and vacuum instruments, actuation systems and momentum wheels

BRUSH DC TORQUE MOTORS

Design Considerations
All diameters listed have finished, ground lamination surfaces. They can be complemented with rings and hubs for mounting convenience.

Moog torque motors are normally delivered in kit form.

If you require integral bearings such as, a cartridge assembly containing a torquer motor and synchro, potentiometer or similar component, we can design the entire assembly to your mechanical dimensions and performance requirements.

Mounting Considerations
Since torque motors are normally delivered in kit form, you provide the mounting surfaces and bearings. When you design the mechanics of the mount, be sure to observe these rules:

1. Eccentricities from the inner member mounting surface should not exceed 0.002 inches for Alnico designs and 0.004 inches for rare earth motor designs.

2. Surfaces in contact with the permanent magnet portion of the motor must be non-magnetic.

3. The bore of the mounting surface should be perpendicular to the mounting seat within 0.001 inch for Alnico designs and 0.002 inches for rare earth designs.

Electrical Considerations
For each mechanical configuration shown, different winding designs to modify torque, torque sensitivity, DC resistance, and so on, can be supplied by Moog to suit your special system requirement. In each case, you have the option of selecting one of the existing designs or specifying a new winding designed to meet your special requirements. If your power source (voltage or current) is limited, the mathematical relationships shown in Table 1 will allow you to calculate a particular performance characteristic at the voltage or power capability of your existing power supply.

The following frame sizes represent only a small sampling of the total range manufactured. Consult factory for additional designs. Refer to our online documentation for product updates.

- Brush torque motors range from 1.125 to 10.2 inches O.D.
- Tachometers range in similar configurations and specifications.
- Torque motors and tachometers are designed to meet the requirements of MIL-E-5400.
- All published parameters are considered nominal (25°C) unless otherwise specified.
- We are currently tooled on some items to house the torque motor on its own bearings and incorporate, if required, a potentiometer and a tachometer.
- Windings can be modified for specific applications.

Brush type DC cube servomotors are also available from Moog.

Conversion Factors
For convenience of calculation or comparison, the following constants are provided for rapid conversion to or from the units Moog uses to express torque motor parameters.

TABLE 1

Parameter	Symbol	Units	Relationship To Published Parameter
Electrical Time Constant	τ_E	ms	L_M / R_M
Mechanical Time Constant	τ_M	ms	$\dfrac{J_M \bullet R_M}{K_E \bullet K_T}$
Power Input, Stalled At Peak Torque (25°C)	P_P	watts	$V_P \bullet I_P$
Viscous Damping Coefficients Zero Source Impedance Infinite Source Impedance	F_O F_I	oz-in per rad/s oz-in per rad/s	$\dfrac{K_T \bullet K_E}{R_M}$ Small % of F_O
Motor Friction Torque (Actual)	T_F	oz-in	T_F
Maximum Power Rate	P	oz-in / s²	T_P^2 / J_M
Maximum Theoretical Acceleration	$\propto_M$		T_P / J_M
Theoretical No Load Speed	ω_{NL}		V_P / K_E

[1] T_F is specified as a maximum value and includes brush friction, magnetic detent and test fixture bearing friction which is considered negligible.

[2] In cases where motor is to be operated at some voltage less than V_P due to power supply limitations the new ω_{NL} becomes V_A / K_E where V_A = voltage applied.

CONVERSION TABLE

From	To	Multiply By
Length		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281×10^{-2}
Mass		
oz	g	28.35
lb	g	453.6
g	oz	3.527×10^{-2}
lb	oz	16.0
g	lb	2.205×10^{-3}
oz	lb	6.250×10^{-2}
Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383×10^4
g-cm	oz-in	1.389×10^{-2}
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233×10^{-5}
oz-in	lb-ft	5.208×10^{-3}
Rotation		
rpm	degrees/s	6.0
rad/s	degrees/s	57.30
degrees/s	rpm	.1667
rad/s	rpm	9.549
degrees/s	rad/s	1.745×10^{-2}
rpm	rad/s	.1047
Moment Of Inertia		
oz-in²	g-cm²	182.9
lb-ft²	g-cm²	4.214×10^5
g-cm²	oz-in²	5.467×10^{-3}
lb-ft²	oz-in²	2.304×10^3
g-cm²	lb-ft²	2.373×10^{-6}
oz-in²	lb-ft²	4.340×10^{-4}
oz-in-sec²	g-cm²	7.062×10^4

D-1125-A-4 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	6.6
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.929
Number of Poles		4
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	1.50E-04
Friction Torque, T_F	oz-in	0.20
Electrical Time Constant, T_E	ms	0.246
Mechanical Time Constant, T_M	ms	25.00
Temperature Rise, TPR'	°C / W	34
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	3.45
Back EMF, K_E	V per rad/s	0.024
Terminal Resistance, R_M	ohms (nom)	13.8
Terminal Inductance, L_M	mH (nom)	3.4
Voltage, Stalled at Peak Torque, V_P	volts	26.4
Amps at Peak Torque, I_P	amps	1.91

MECHANICAL DIMENSIONS (INCHES)
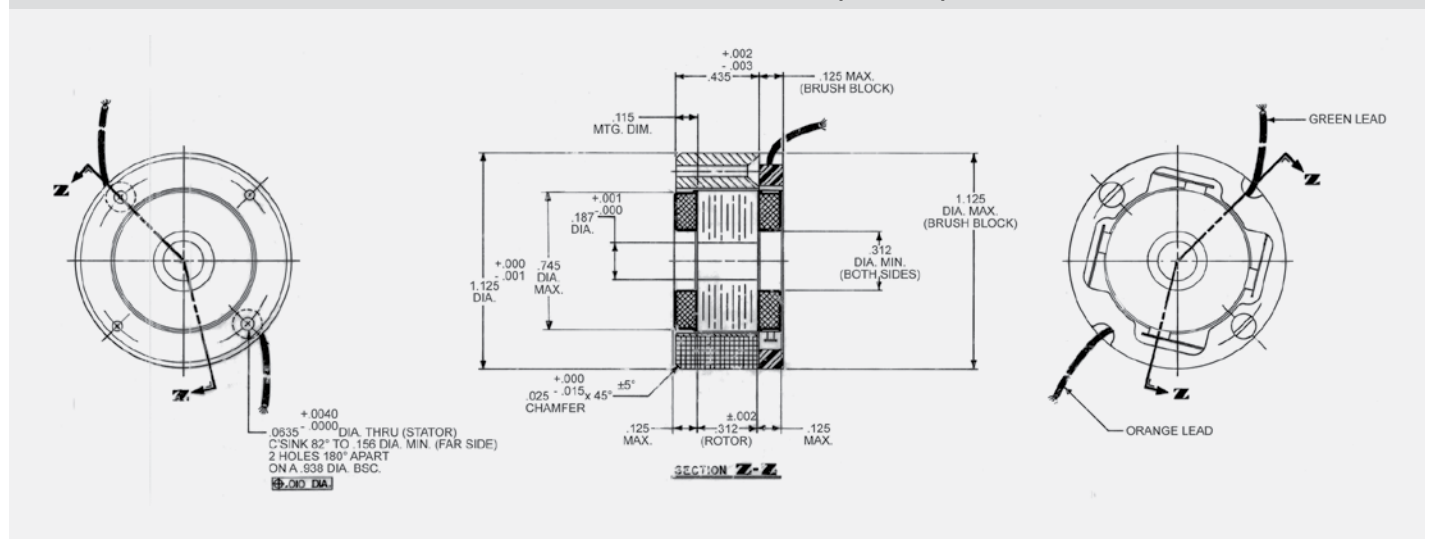
D-1125-B-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	6.6
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.899
Number of Poles		4
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	1.50E-04
Friction Torque, T_F	oz-in	0.20
Electrical Time Constant, T_E	ms	0.216
Mechanical Time Constant, T_M	ms	26.24
Temperature Rise, TPR'	°C / W	33
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	4.10
Back EMF, K_E	V per rad/s	0.029
Terminal Resistance, R_M	ohms (nom)	20.8
Terminal Inductance, L_M	mH (nom)	4.5
Voltage, Stalled at Peak Torque, V_P	volts	33.3
Amps at Peak Torque, I_P	amps	1.60

MECHANICAL DIMENSIONS (INCHES)

D-1125-F-10-T SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	6.6
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.865
Number of Poles		4
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	1.50E-04
Friction Torque, T_F	oz-in	0.20
Electrical Time Constant, T_E	ms	0.246
Mechanical Time Constant, T_M	ms	28.41
Temperature Rise, TPR'	°C / W	34
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	3.12
Back EMF, K_E	V per rad/s	0.022
Terminal Resistance, R_M	ohms (nom)	13
Terminal Inductance, L_M	mH (nom)	3.2
Voltage, Stalled at Peak Torque, V_P	volts	27.6
Amps at Peak Torque, I_P	amps	2.12

MECHANICAL DIMENSIONS (INCHES)

SECTION Z-Z

VIEW X-X

D-1125-N-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	6.6
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.899
Number of Poles		4
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	1.50E-04
Friction Torque, T_F	oz-in	0.20
Electrical Time Constant, T_E	ms	0.216
Mechanical Time Constant, T_M	ms	26.24
Temperature Rise, TPR'	°C / W	33
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	4.10
Back EMF, K_E	V per rad/s	0.029
Terminal Resistance, R_M	ohms (nom)	20.8
Terminal Inductance, L_M	mH (nom)	4.5
Voltage, Stalled at Peak Torque, V_P	volts	33.3
Amps at Peak Torque, I_P	amps	1.60

MECHANICAL DIMENSIONS (INCHES)

D-1125-P-10 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	6.6
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.87
Number of Poles		4
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	1.50E-04
Friction Torque, T_F	oz-in	0.20
Electrical Time Constant, T_E	ms	0.246
Mechanical Time Constant, T_M	ms	28.4
Temperature Rise, TPR'	°C / W	34
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	3.12
Back EMF, K_E	V per rad/s	0.022
Terminal Resistance, R_M	ohms (nom)	13
Terminal Inductance, L_M	mH (nom)	3.2
Voltage, Stalled at Peak Torque, V_P	volts	27.6
Amps at Peak Torque, I_P	amps	2.12

MECHANICAL DIMENSIONS (INCHES)

D-1125-P-7 / K044 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	6.6
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.851
Number of Poles		4
Weight	oz (nom)	1.8
Motor Inertia, J_M	oz-in-s^2	1.50E-04
Friction Torque, T_F	oz-in	0.20
Electrical Time Constant, T_E	ms	0.231
Mechanical Time Constant, T_M	ms	29.26
Temperature Rise, TPR'	°C / W	34
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	4.95
Back EMF, K_E	V per rad/s	0.035
Terminal Resistance, R_M	ohms (nom)	33.8
Terminal Inductance, L_M	mH (nom)	7.8
Voltage, Stalled at Peak Torque, V_P	volts	45.0
Amps at Peak Torque, I_P	amps	1.33

MECHANICAL DIMENSIONS (INCHES)
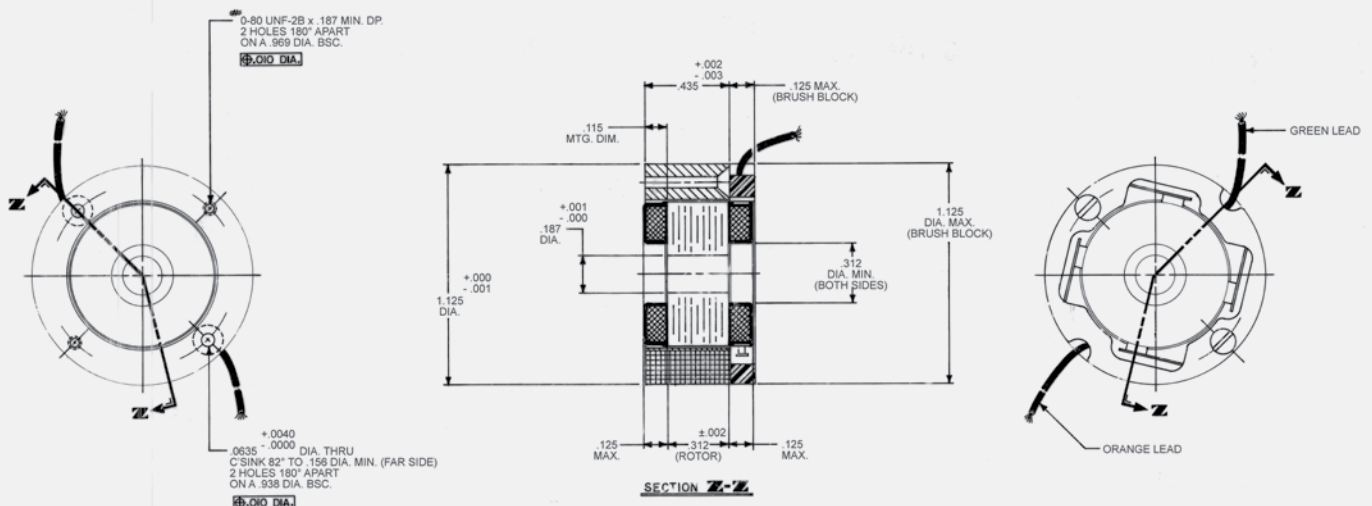
D-1375-F-2ANS SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	43
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.70
Number of Poles		8
Weight	oz (nom)	2.4
Motor Inertia, J_M	oz-in-s^2	5.35E-04
Friction Torque, T_F	oz-in	0.88
Electrical Time Constant, T_E	ms	0.172
Mechanical Time Constant, T_M	ms	10.24
Temperature Rise, TPR'	°C / W	17
Ripple Torque, T_R	max. avg. to peak (%)	6

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	5.05
Back EMF, K_E	V per rad/s	0.036
Terminal Resistance, R_M	ohms (nom)	3.48
Terminal Inductance, L_M	mH (nom)	0.60
Voltage, Stalled at Peak Torque, V_P	volts	30.0
Amps at Peak Torque, I_P	amps	8.62

MECHANICAL DIMENSIONS (INCHES)
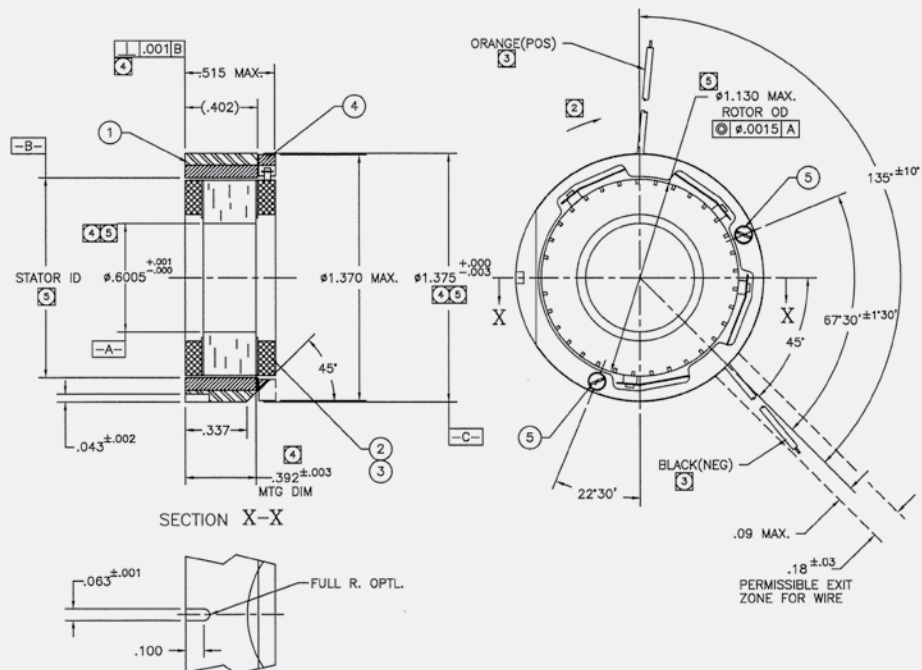
D-1500-C-3 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	15
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.78
Number of Poles		6
Weight	oz (nom)	2.4
Motor Inertia, J_M	oz-in-s^2	5.50E-04
Friction Torque, T_F	oz-in	0.50
Electrical Time Constant, T_E	ms	0.368
Mechanical Time Constant, T_M	ms	24.36
Temperature Rise, TPR'	°C / W	19
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	5.50
Back EMF, K_E	V per rad/s	0.039
Terminal Resistance, R_M	ohms (nom)	9.5
Terminal Inductance, L_M	mH (nom)	3.5
Voltage, Stalled at Peak Torque, V_P	volts	25.9
Amps at Peak Torque, I_P	amps	2.73

MECHANICAL DIMENSIONS (INCHES)
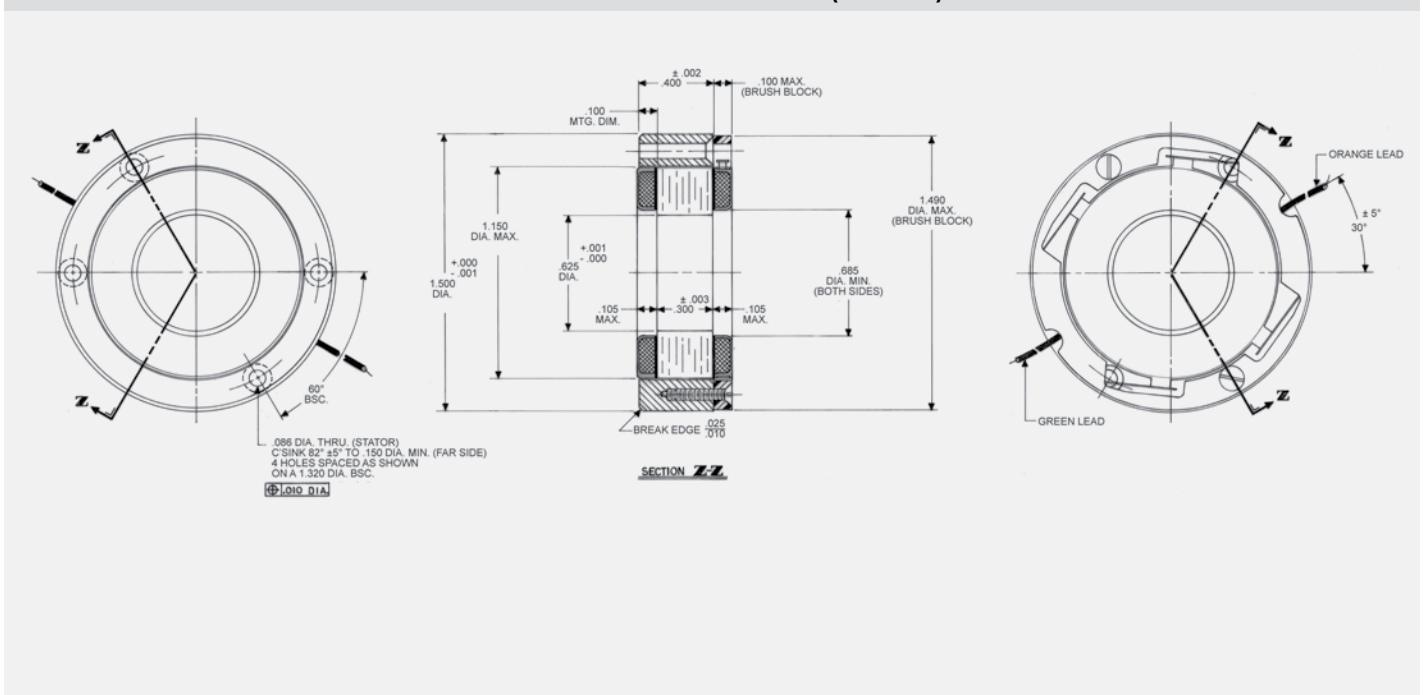
D-1500-E-6 / K012 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	15
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.01
Number of Poles		6
Weight	oz (nom)	2.4
Motor Inertia, J_M	oz-in-s^2	5.50E-04
Friction Torque, T_F	oz-in	0.50
Electrical Time Constant, T_E	ms	0.304
Mechanical Time Constant, T_M	ms	19.38
Temperature Rise, TPR'	°C / W	19
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	6.80
Back EMF, K_E	V per rad/s	0.048
Terminal Resistance, R_M	ohms (nom)	11.5
Terminal Inductance, L_M	mH (nom)	3.5
Voltage, Stalled at Peak Torque, V_P	volts	25.4
Amps at Peak Torque, I_P	amps	2.21

MECHANICAL DIMENSIONS (INCHES)
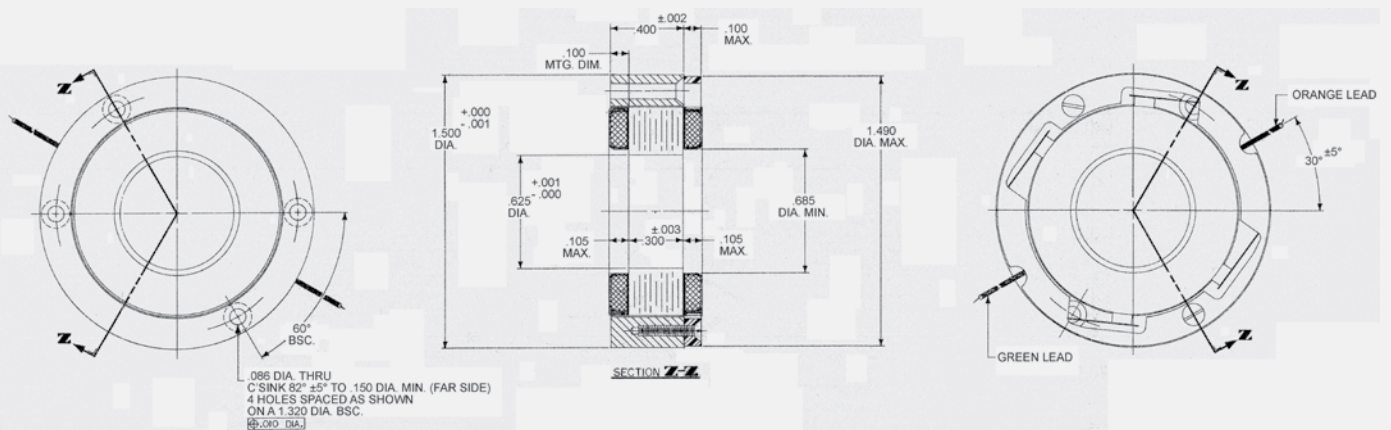
D-1500-Y-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	18.2
Motor Constant, K_M	oz-in / $\sqrt{W}$	3.0
Number of Poles		6
Weight	oz (nom)	6.4
Motor Inertia, J_M	oz-in-s^2	0.0014
Friction Torque, T_F	oz-in	0.95
Electrical Time Constant, T_E	ms	0.45
Mechanical Time Constant, T_M	ms	22.0
Temperature Rise, TPR'	°C / W	12
Ripple Torque, T_R	max. avg. to peak (%)	10

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	13.8
Back EMF, K_E	V per rad/s	0.98
Terminal Resistance, R_M	ohms (nom)	20.69
Terminal Inductance, L_M	mH (nom)	8.15
Voltage, Stalled at Peak Torque, V_P	volts	28.0
Amps at Peak Torque, I_P	amps	1.3

MECHANICAL DIMENSIONS (INCHES)
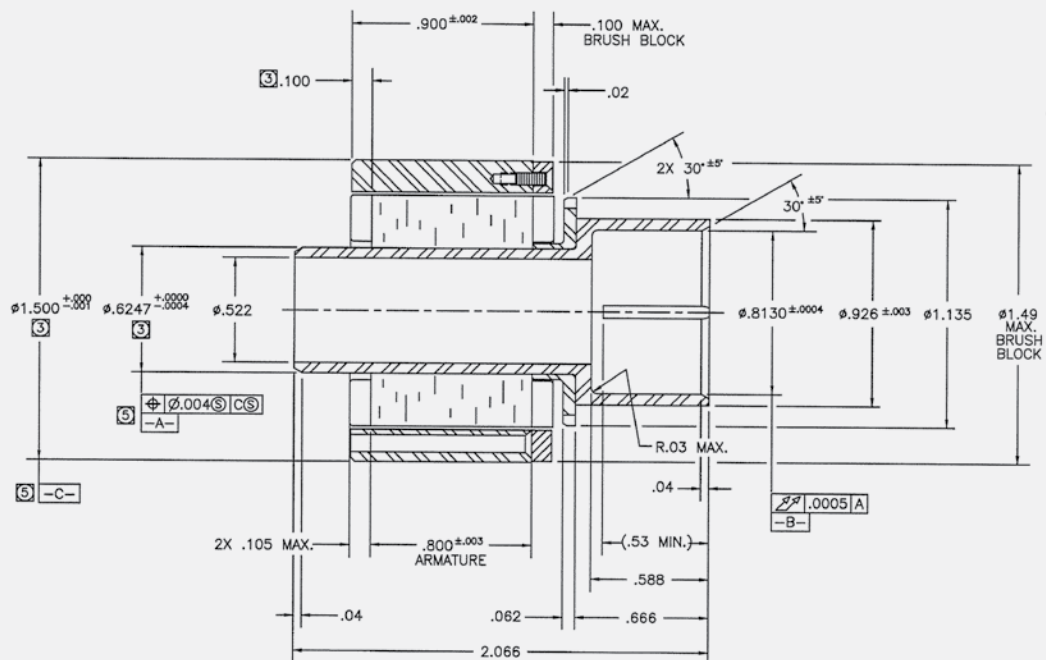
D-1500-Z-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	18
Motor Constant, K_M	oz-in / $\sqrt{W}$	3.02
Number of Poles		6
Weight	oz (nom)	6.4
Motor Inertia, J_M	oz-in-s^2	1.40E-03
Friction Torque, T_F	oz-in	0.95
Electrical Time Constant, T_E	ms	0.451
Mechanical Time Constant, T_M	ms	21.72
Temperature Rise, TPR'	°C / W	12
Ripple Torque, T_R	max. avg. to peak (%)	10

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	14
Back EMF, K_E	V per rad/s	0.099
Terminal Resistance, R_M	ohms (nom)	21.5
Terminal Inductance, L_M	mH (nom)	9.7
Voltage, Stalled at Peak Torque, V_P	volts	28
Amps at Peak Torque, I_P	amps	1.30

MECHANICAL DIMENSIONS (INCHES)
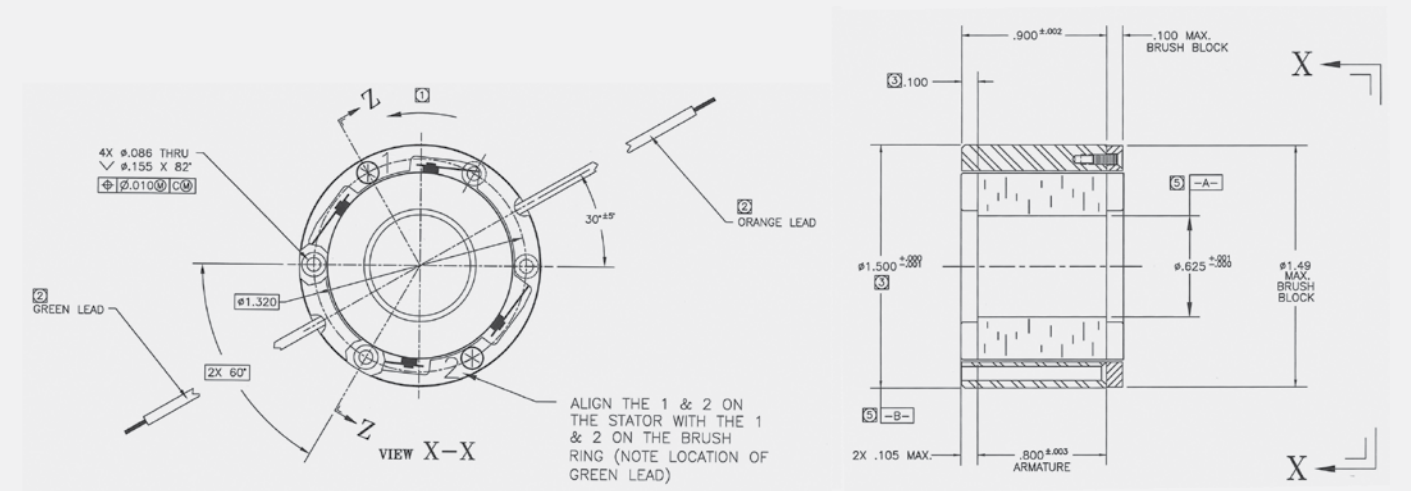
D-1938-R-1AN SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	12.9
Motor Constant, K_M	oz-in / $\sqrt{W}$	2.8
Number of Poles		6
Weight	oz (nom)	2.80
Motor Inertia, J_M	oz-in-s^2	0.0008
Friction Torque, T_F	oz-in	0.65
Electrical Time Constant, T_E	ms	0.31
Mechanical Time Constant, T_M	ms	14.4
Temperature Rise, TPR'	°C / W	19

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	15.9
Back EMF, K_E	V per rad/s	0.112
Terminal Resistance, R_M	ohms (nom)	32.8
Terminal Inductance, L_M	mH (nom)	10
Voltage, Stalled at Peak Torque, V_P	volts	26.0
Amps at Peak Torque, I_P	amps	0.807

MECHANICAL DIMENSIONS (INCHES)
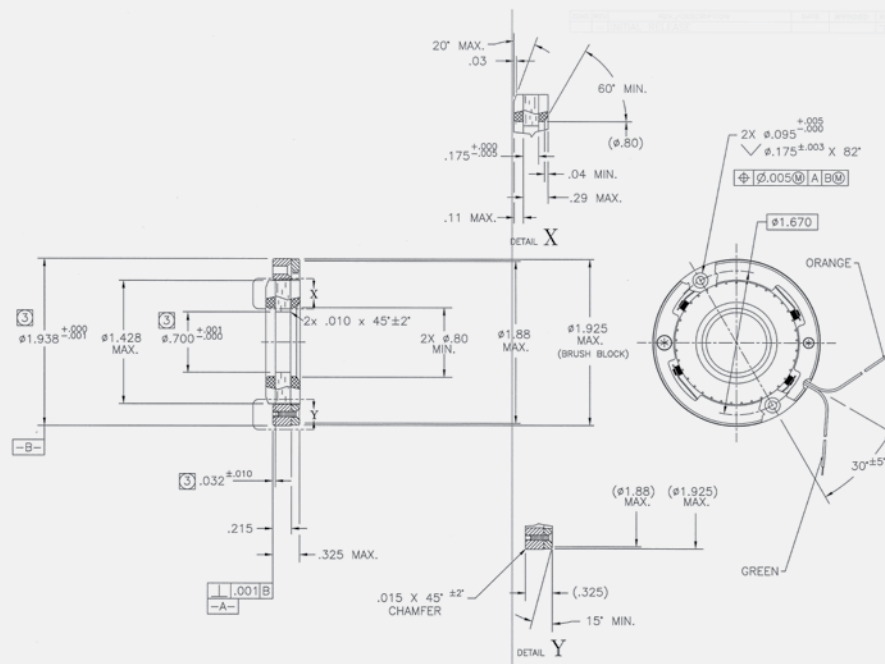
D-2000-D-1NS SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	108
Motor Constant, K_M	oz-in / $\sqrt{W}$	8.06
Number of Poles		8
Weight	oz (nom)	6.7
Motor Inertia, J_M	oz-in-s^2	3.25E-03
Friction Torque, T_F	oz-in	6.0
Electrical Time Constant, T_E	ms	0.032
Mechanical Time Constant, T_M	ms	7.08
Temperature Rise, TPR'	°C / W	10

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	18.0
Back EMF, K_E	V per rad/s	0.127
Terminal Resistance, R_M	ohms (nom)	4.99
Terminal Inductance, L_M	mH (nom)	1.6
Voltage, Stalled at Peak Torque, V_P	volts	29.9
Amps at Peak Torque, I_P	amps	6.00

MECHANICAL DIMENSIONS (INCHES)
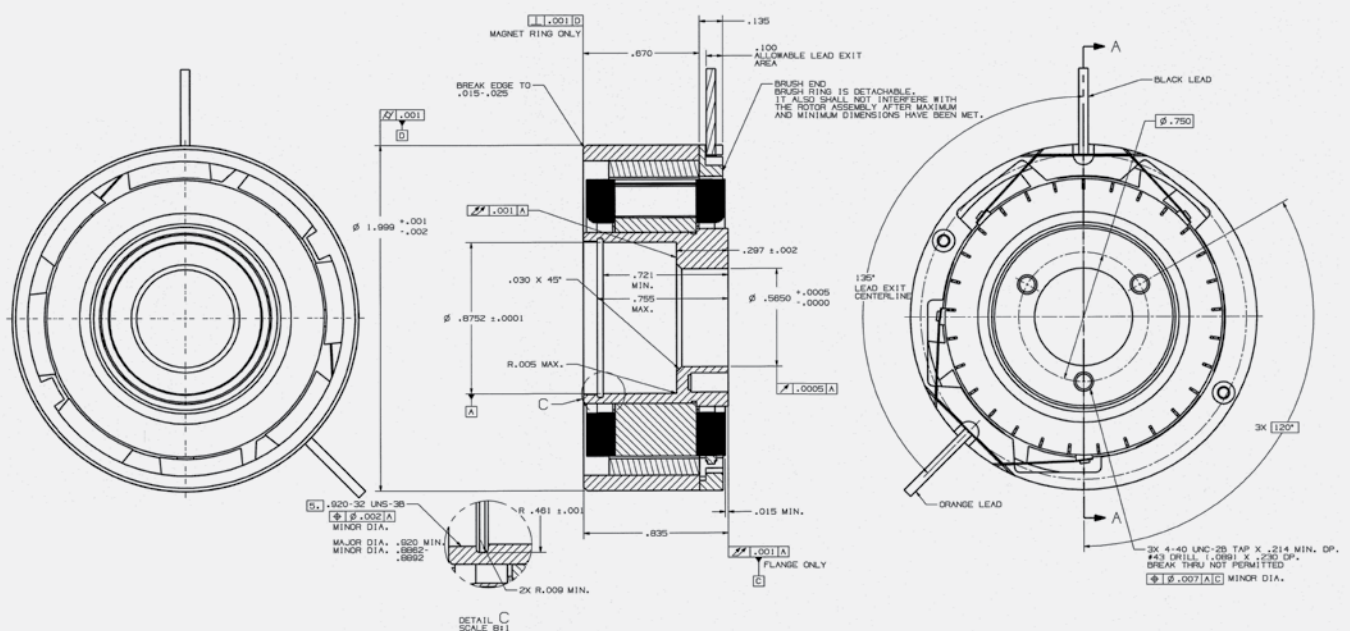
D-2780-B-1AEN SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	14
Motor Constant, K_M	oz-in / $\sqrt{W}$	4.05
Number of Poles		10
Weight	oz (nom)	4
Motor Inertia, J_M	oz-in-s^2	5.00E-03
Friction Torque, T_F	oz-in	1.2
Electrical Time Constant, T_E	ms	0.123
Mechanical Time Constant, T_M	ms	43.12
Temperature Rise, TPR'	°C / W	5.7
Ripple Torque, T_R	max. avg. to peak (%)	6

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	30.6
Back EMF, K_E	V per rad/s	0.216
Terminal Resistance, R_M	ohms (nom)	57
Terminal Inductance, L_M	mH (nom)	7
Voltage, Stalled at Peak Torque, V_P	volts	26
Amps at Peak Torque, I_P	amps	0.46

MECHANICAL DIMENSIONS (INCHES)
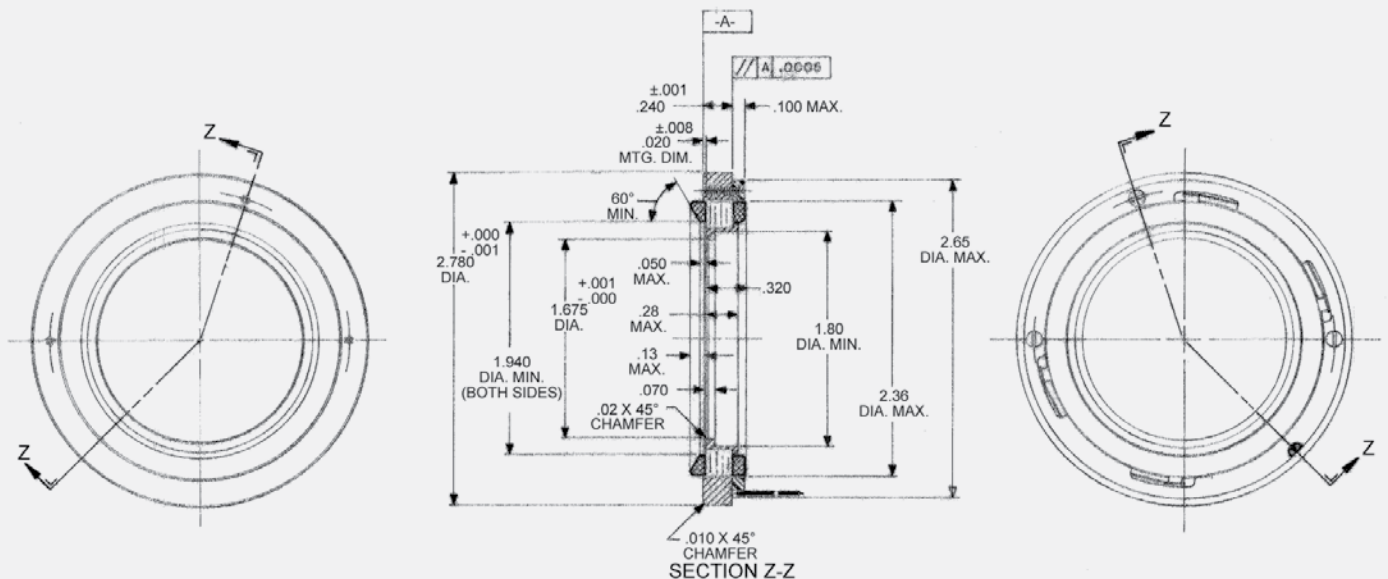
D-2813-G-1HT SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	95
Motor Constant, K_M	oz-in / √W	15.3
Number of Poles		8
Weight	oz (nom)	21
Motor Inertia, J_M	oz-in-s²	1.40E-03
Friction Torque, T_F	oz-in	2.5
Electrical Time Constant, T_E	ms	0.575
Mechanical Time Constant, T_M	ms	8.82
Temperature Rise, TPR'	°C / W	7
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	43.3
Back EMF, K_E	V per rad/s	0.306
Terminal Resistance, R_M	ohms (nom)	8
Terminal Inductance, L_M	mH (nom)	4.6
Voltage, Stalled at Peak Torque, V_P	volts	17.6
Amps at Peak Torque, I_P	amps	2.2

MECHANICAL DIMENSIONS (INCHES)
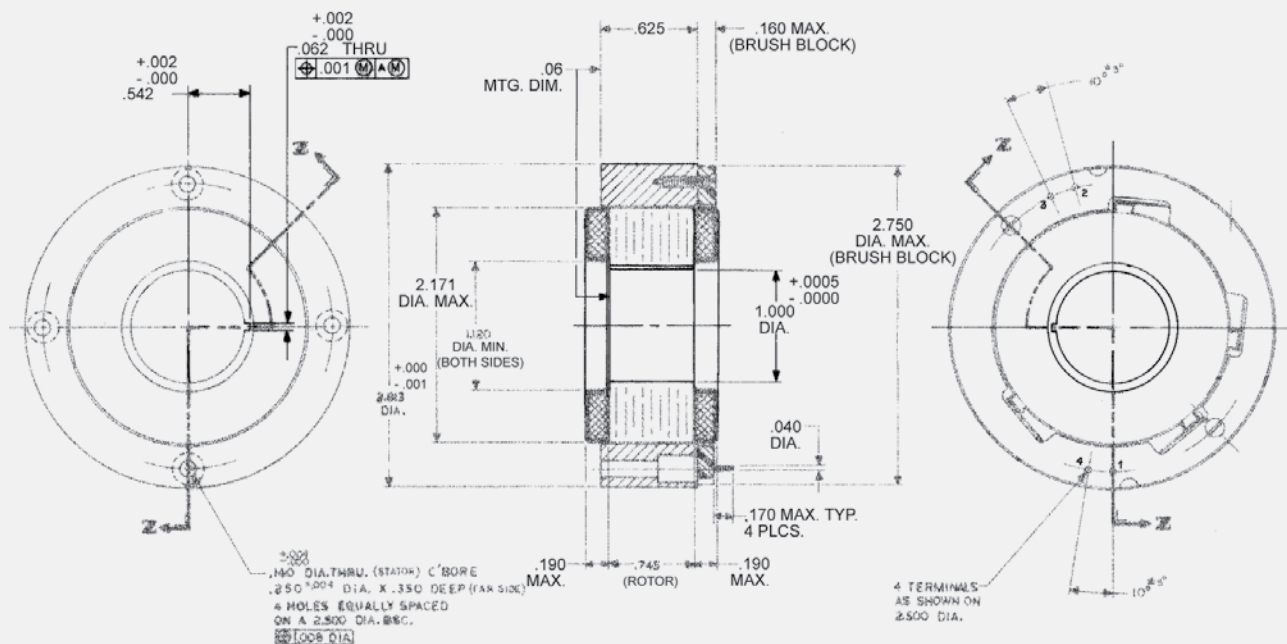
D-2910-B-1ENS SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	165
Motor Constant, K_M	oz-in / $\sqrt{W}$	10.2
Number of Poles		10
Weight	oz (nom)	9.5
Motor Inertia, J_M	oz-in-s^2	1.25E-02
Friction Torque, T_F	oz-in	3
Electrical Time Constant, T_E	ms	0.319
Mechanical Time Constant, T_M	ms	16.84
Temperature Rise, TPR'	°C / W	7.5
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	16.5
Back EMF, K_E	V per rad/s	0.117
Terminal Resistance, R_M	ohms (nom)	2.6
Terminal Inductance, L_M	mH (nom)	0.83
Voltage, Stalled at Peak Torque, V_P	volts	26
Amps at Peak Torque, I_P	amps	10

MECHANICAL DIMENSIONS (INCHES)
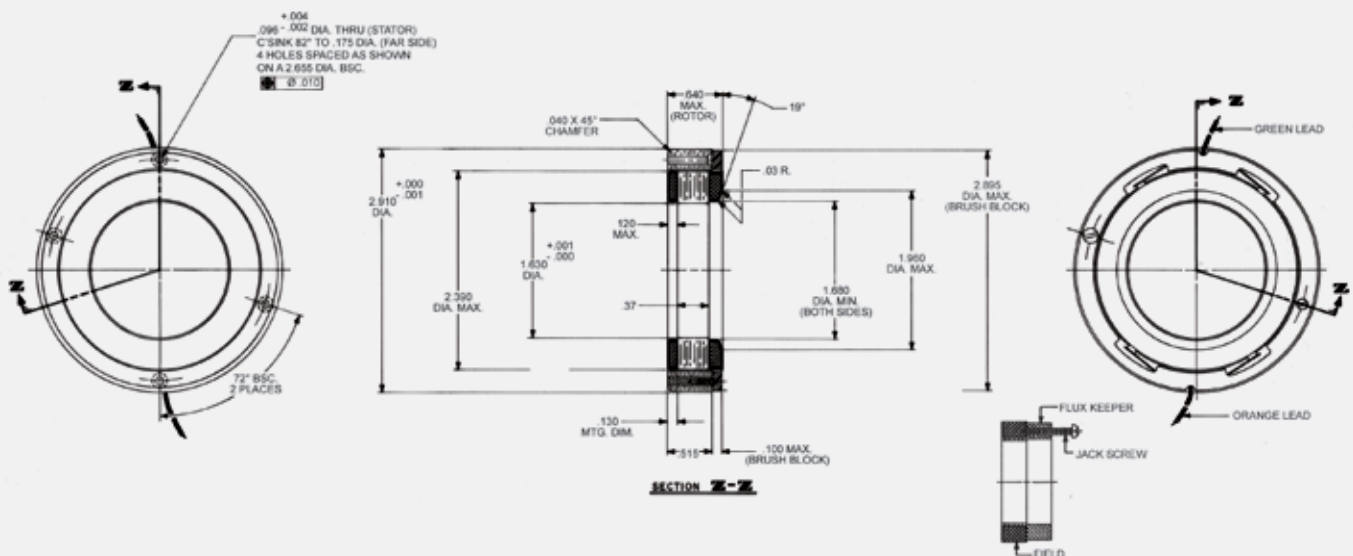
D-2910-G-1ENS SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	59
Motor Constant, K_M	oz-in / $\sqrt{W}$	9.66
Number of Poles		10
Weight	oz (nom)	9.5
Motor Inertia, J_M	oz-in-s^2	1.25E-02
Friction Torque, T_F	oz-in	1.2
Electrical Time Constant, T_E	ms	0.333
Mechanical Time Constant, T_M	ms	18.92
Temperature Rise, TPR'	°C / W	7.5
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	41
Back EMF, K_E	V per rad/s	0.29
Terminal Resistance, R_M	ohms (nom)	18
Terminal Inductance, L_M	mH (nom)	6
Voltage, Stalled at Peak Torque, V_P	volts	26.1
Amps at Peak Torque, I_P	amps	1.45

MECHANICAL DIMENSIONS (INCHES)
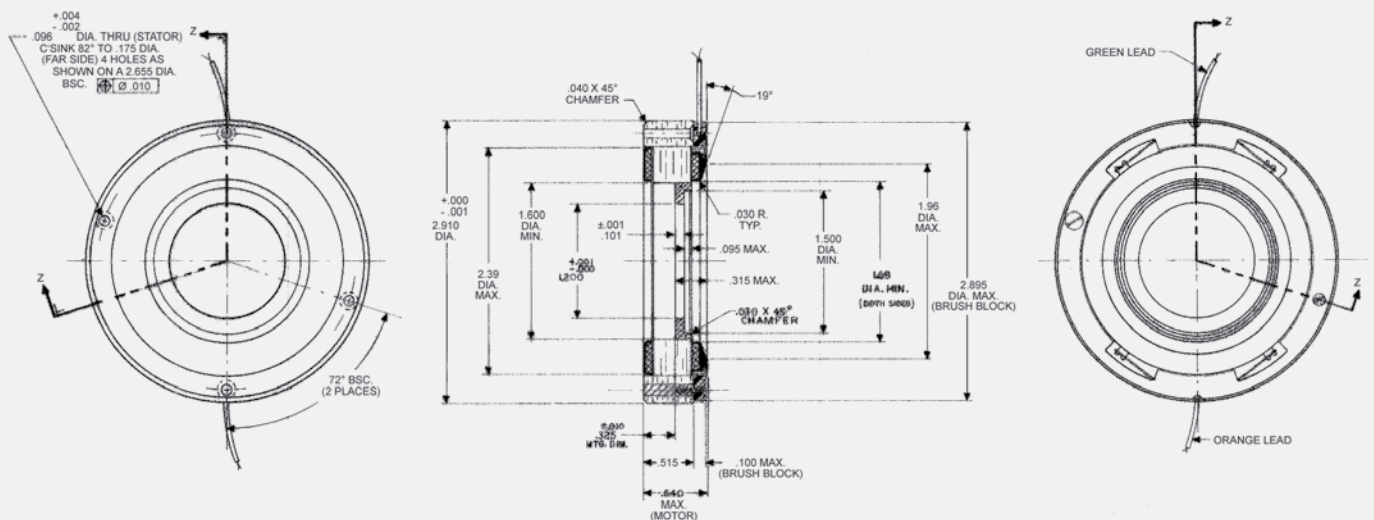
D-3000-F-1T SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	93
Motor Constant, K_M	oz-in / $\sqrt{W}$	12.2
Number of Poles		10
Weight	oz (nom)	9.7
Motor Inertia, J_M	oz-in-s^2	1.60E-02
Friction Torque, T_F	oz-in	2.5
Electrical Time Constant, T_E	ms	0.615
Mechanical Time Constant, T_M	ms	15.32
Temperature Rise, TPR'	°C / W	6.5
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	62
Back EMF, K_E	V per rad/s	0.438
Terminal Resistance, R_M	ohms (nom)	26
Terminal Inductance, L_M	mH (nom)	16
Voltage, Stalled at Peak Torque, V_P	volts	39
Amps at Peak Torque, I_P	amps	1.5

MECHANICAL DIMENSIONS (INCHES)
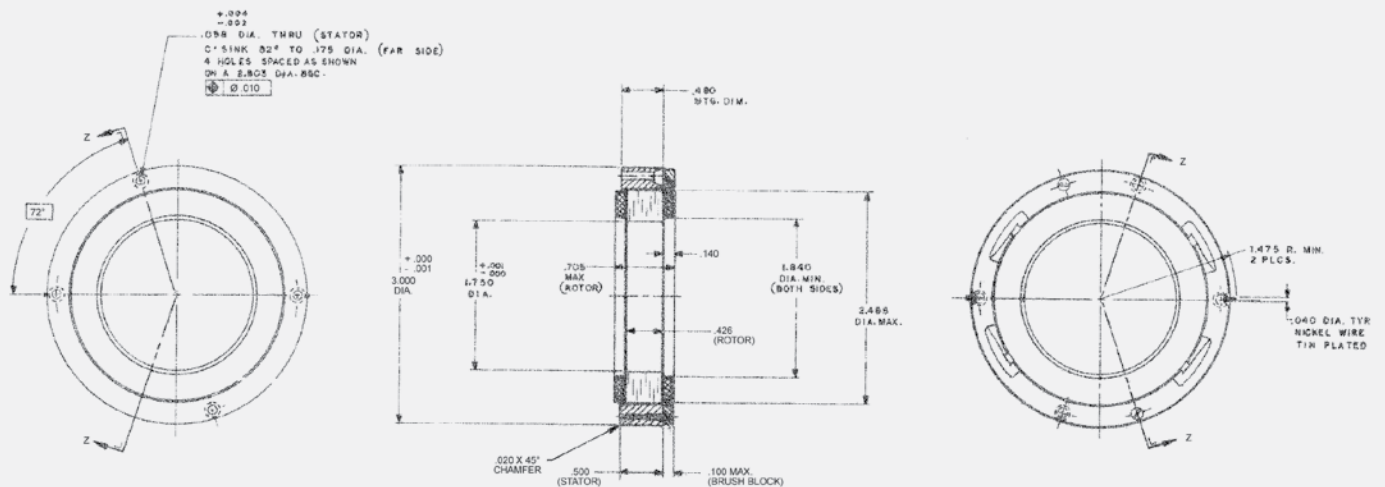
D-3000-F-3T SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	95
Motor Constant, K_M	oz-in / $\sqrt{W}$	12.2
Number of Poles		10
Weight	oz (nom)	9.7
Motor Inertia, J_M	oz-in-s^2	1.60E-02
Friction Torque, T_F	oz-in	2.5
Electrical Time Constant, T_E	ms	0.622
Mechanical Time Constant, T_M	ms	15.34
Temperature Rise, TPR'	°C / W	6.5
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	28
Back EMF, K_E	V per rad/s	0.198
Terminal Resistance, R_M	ohms (nom)	5.3
Terminal Inductance, L_M	mH (nom)	3.3
Voltage, Stalled at Peak Torque, V_P	volts	18
Amps at Peak Torque, I_P	amps	3.40

MECHANICAL DIMENSIONS (INCHES)
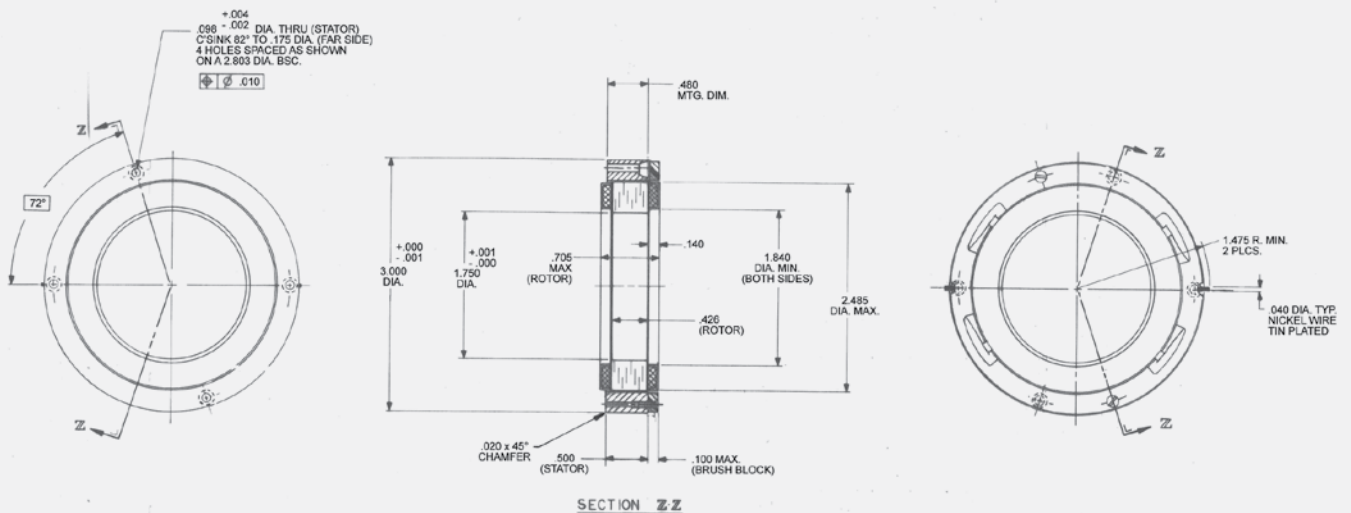
D-3029-A-2EN SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	37
Motor Constant, K_M	oz-in / $\sqrt{W}$	7.85
Number of Poles		10
Weight	oz (nom)	6.5
Motor Inertia, J_M	oz-in-s^2	1.24E-02
Friction Torque, T_F	oz-in	1
Electrical Time Constant, T_E	ms	0.50
Mechanical Time Constant, T_M	ms	28.46
Temperature Rise, TPR'	°C / W	8.0
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	43
Back EMF, K_E	V per rad/s	0.304
Terminal Resistance, R_M	ohms (nom)	30
Terminal Inductance, L_M	mH (nom)	15
Voltage, Stalled at Peak Torque, V_P	volts	26
Amps at Peak Torque, I_P	amps	0.87

MECHANICAL DIMENSIONS (INCHES)
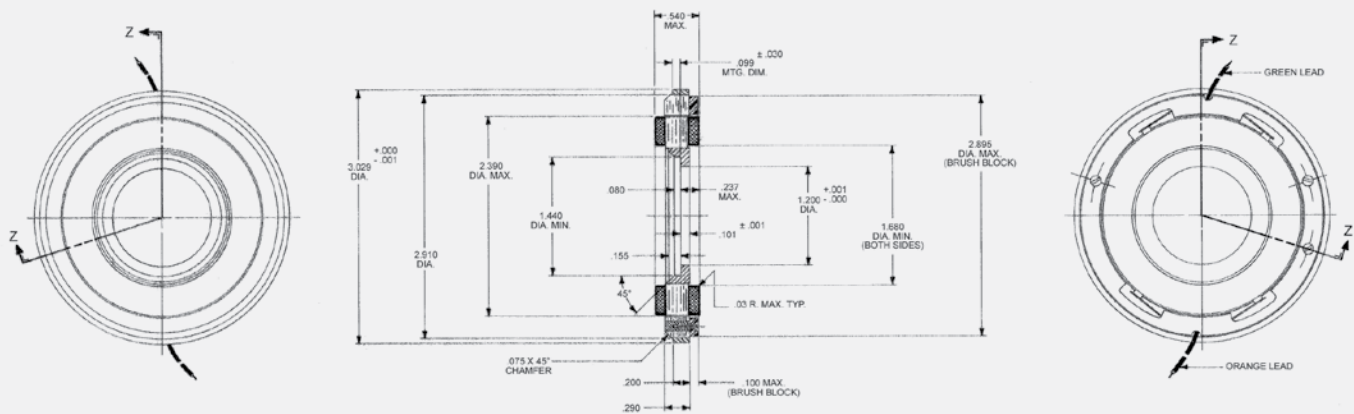
D-3180-C-2A SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	480
Motor Constant, K_M	oz-in / $\sqrt{W}$	29.8
Number of Poles		10
Weight	oz (nom)	36
Motor Inertia, J_M	oz-in-s^2	3.50E-02
Friction Torque, T_F	oz-in	10
Electrical Time Constant, T_E	ms	0.923
Mechanical Time Constant, T_M	ms	5.59
Temperature Rise, TPR'	°C / W	5
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	48
Back EMF, K_E	V per rad/s	0.339
Terminal Resistance, R_M	ohms (nom)	2.60
Terminal Inductance, L_M	mH (nom)	2.4
Voltage, Stalled at Peak Torque, V_P	volts	26
Amps at Peak Torque, I_P	amps	10

MECHANICAL DIMENSIONS (INCHES)

D-3180-C-2AE SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	445
Motor Constant, K_M	oz-in / $\sqrt{W}$	27.6
Number of Poles		10
Weight	oz (nom)	36
Motor Inertia, J_M	oz-in-s^2	3.50E-02
Friction Torque, T_F	oz-in	10
Electrical Time Constant, T_E	ms	0.769
Mechanical Time Constant, T_M	ms	6.51
Temperature Rise, TPR'	°C / W	5
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	44.5
Back EMF, K_E	V per rad/s	0.314
Terminal Resistance, R_M	ohms (nom)	2.60
Terminal Inductance, L_M	mH (nom)	2
Voltage, Stalled at Peak Torque, V_P	volts	24
Amps at Peak Torque, I_P	amps	9.2

MECHANICAL DIMENSIONS (INCHES)
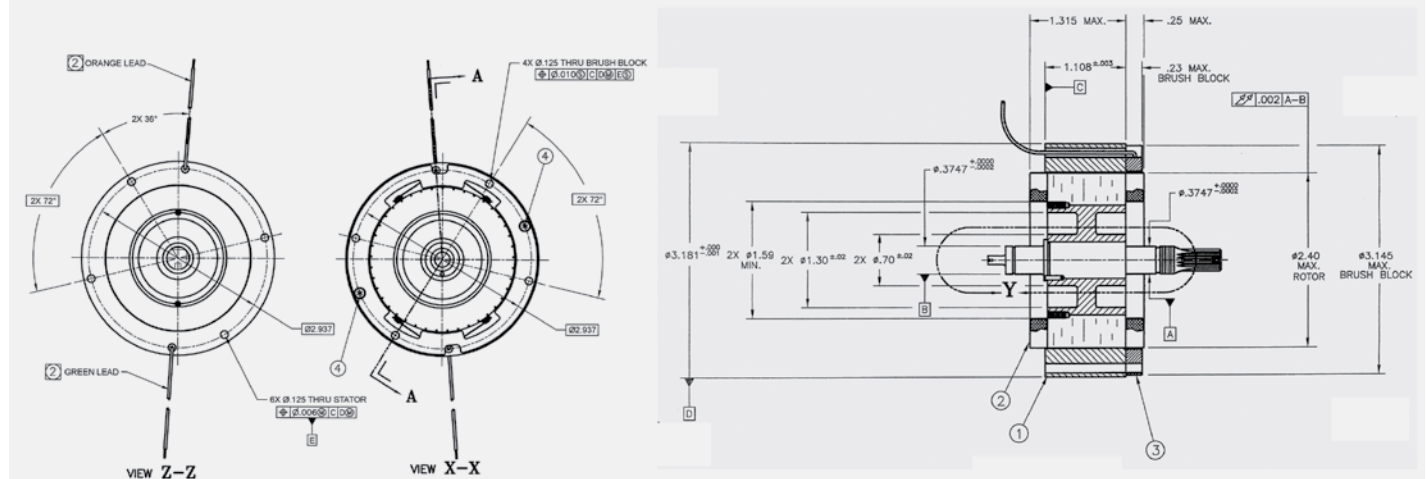
D-3180-G-2AE SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	400
Motor Constant, K_M	oz-in / $\sqrt{W}$	27.6
Number of Poles		10
Weight	oz (nom)	36
Motor Inertia, J_M	oz-in-s^2	0.035
Friction Torque, T_F	oz-in	10
Electrical Time Constant, T_E	ms	0.769
Mechanical Time Constant, T_M	ms	6.51
Temperature Rise, TPR'	°C / W	5
Ripple Torque, T_R	max. avg. to peak (%)	10

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	48
Back EMF, K_E	V per rad/s	0.339
Terminal Resistance, R_M	ohms (nom)	2.60
Terminal Inductance, L_M	mH (nom)	3.2
Voltage, Stalled at Peak Torque, V_P	volts	26.0
Amps at Peak Torque, I_P	amps	9.23

MECHANICAL DIMENSIONS (INCHES)
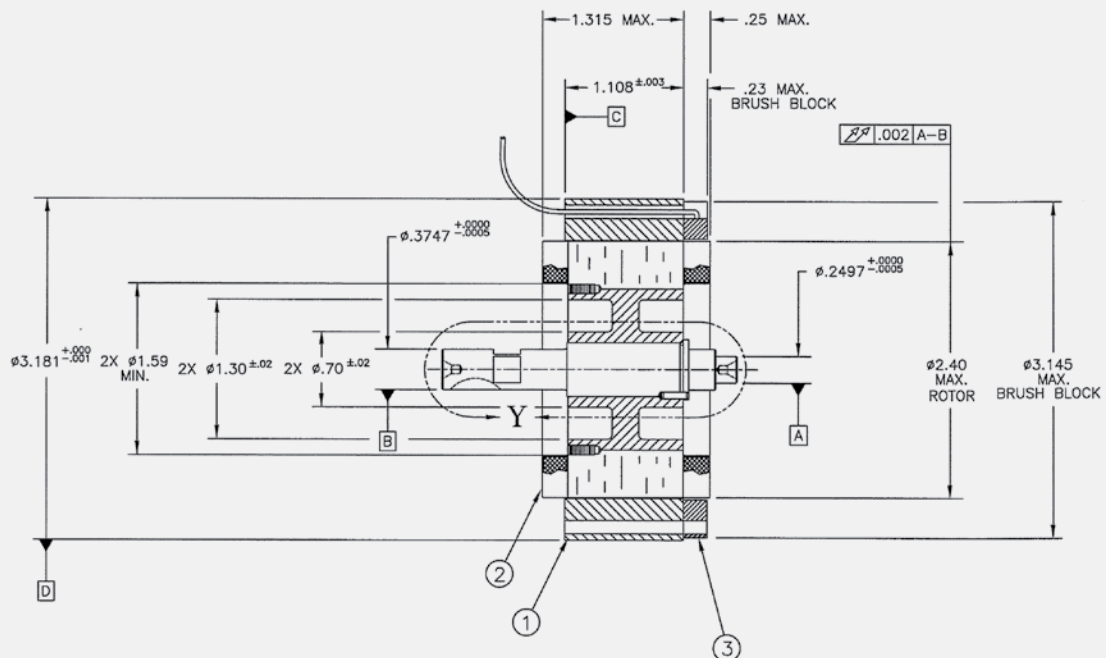
D-3180-P-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	5.07
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.286
Number of Poles		10
Weight	oz (nom)	3.5
Motor Inertia, J_M	oz-in-s^2	3.88×10^{-4}
Friction Torque, T_F	oz-in	0.10
Electrical Time Constant, T_E	ms	1.49
Mechanical Time Constant, T_M	ms	3.50
Temperature Rise, TPR'	°C / W	4.3
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	0.811
Back EMF, K_E	V per rad/s	1.10
Terminal Resistance, R_M	ohms (nom)	8.03
Terminal Inductance, L_M	mH (nom)	12
Voltage, Stalled at Peak Torque, V_P	volts	50.2
Amps at Peak Torque, I_P	amps	6.25

MECHANICAL DIMENSIONS (INCHES)
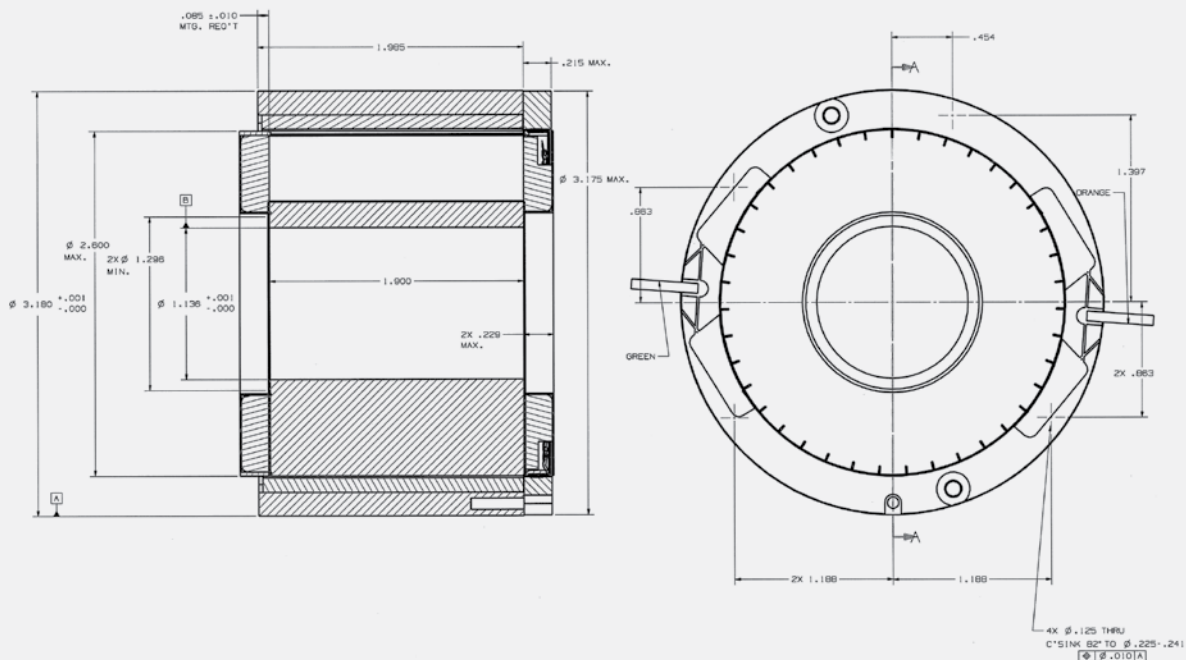
D-3375-A-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	33
Motor Constant, K_M	oz-in / $\sqrt{W}$	9.03
Number of Poles		12
Weight	oz (nom)	8.5
Motor Inertia, J_M	oz-in-s^2	1.60E-02
Friction Torque, T_F	oz-in	2
Electrical Time Constant, T_E	ms	0.243
Mechanical Time Constant, T_M	ms	27.72
Temperature Rise, TPR'	°C / W	6.2
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	41
Back EMF, K_E	V per rad/s	0.290
Terminal Resistance, R_M	ohms (nom)	20.6
Terminal Inductance, L_M	mH (nom)	5
Voltage, Stalled at Peak Torque, V_P	volts	16.5
Amps at Peak Torque, I_P	amps	0.80

MECHANICAL DIMENSIONS (INCHES)
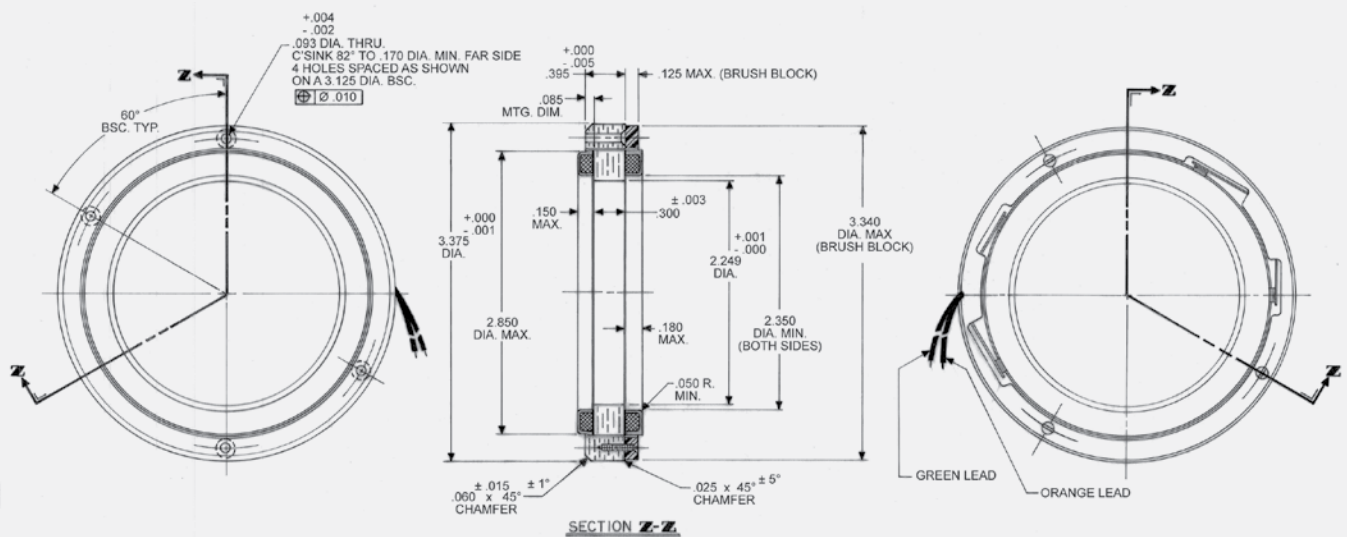
D-3375-A-2 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	58
Motor Constant, K_M	oz-in / $\sqrt{W}$	10
Number of Poles		12
Weight	oz (nom)	8.5
Motor Inertia, J_M	oz-in-s^2	1.63E-02
Friction Torque, T_F	oz-in	2
Electrical Time Constant, T_E	ms	0.243
Mechanical Time Constant, T_M	ms	22.46
Temperature Rise, TPR'	°C / W	6.2
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	46
Back EMF, K_E	V per rad/s	0.325
Terminal Resistance, R_M	ohms (nom)	20.6
Terminal Inductance, L_M	mH (nom)	5
Voltage, Stalled at Peak Torque, V_P	volts	26
Amps at Peak Torque, I_P	amps	1.26

MECHANICAL DIMENSIONS (INCHES)
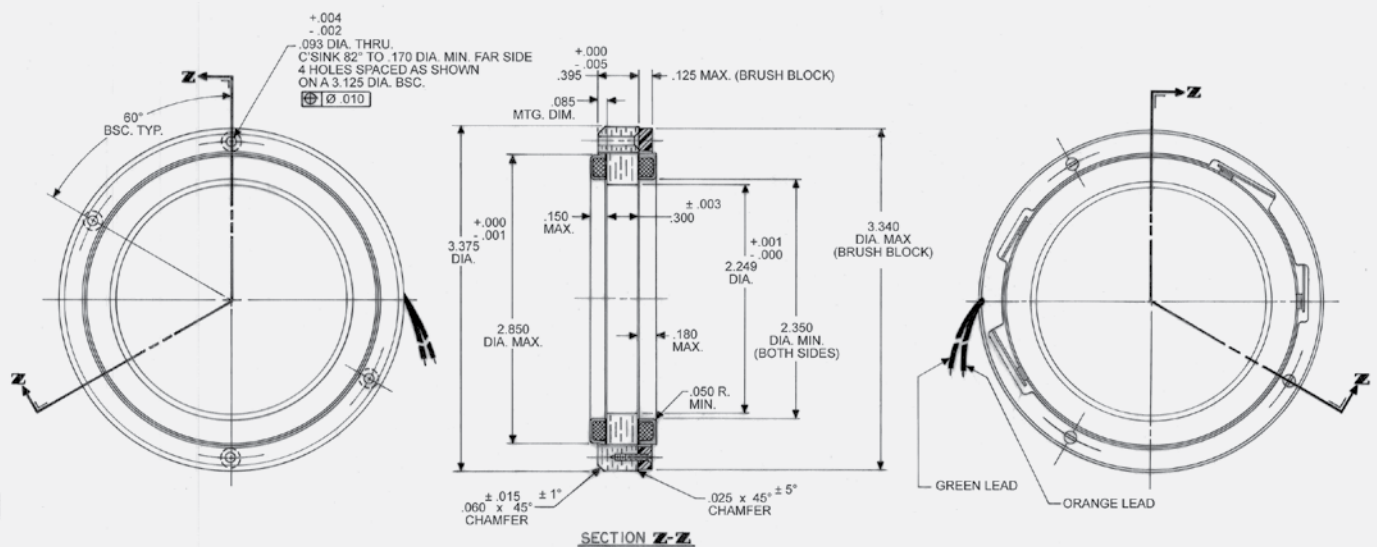
D-4500-B-1AS SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	305
Motor Constant, K_M	oz-in / $\sqrt{W}$	50
Number of Poles		20
Weight	oz (nom)	26
Motor Inertia, J_M	oz-in-s^2	8.50E-02
Friction Torque, T_F	oz-in	5
Electrical Time Constant, T_E	ms	0.353
Mechanical Time Constant, T_M	ms	4.83
Temperature Rise, TPR'	°C / W	2.4
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	92
Back EMF, K_E	V per rad/s	0.650
Terminal Resistance, R_M	ohms (nom)	3.4
Terminal Inductance, L_M	mH (nom)	1.2
Voltage, Stalled at Peak Torque, V_P	volts	11.2
Amps at Peak Torque, I_P	amps	3.31

MECHANICAL DIMENSIONS (INCHES)
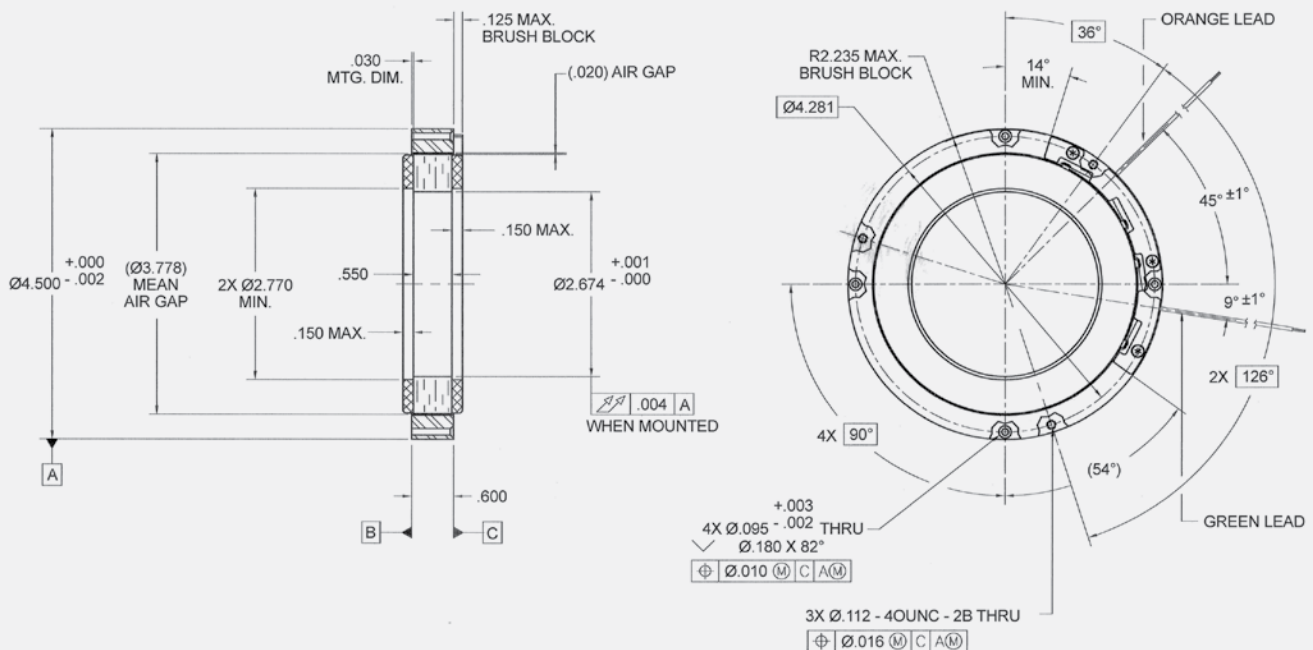
D-4610-B-1AS SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	260.6
Motor Constant, K_M	oz-in / √W	21.02
Number of Poles		16
Weight	oz (nom)	13
Motor Inertia, J_M	oz-in-s^2	5.958E+00
Friction Torque, T_F	oz-in	8.00
Electrical Time Constant, T_E	ms	0.326
Mechanical Time Constant, T_M	ms	19.09
Temperature Rise, TPR'	°C / W	4.73
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	63.411
Back EMF, K_E	V per rad/s	0.448
Terminal Resistance, R_M	ohms (nom)	9.10
Terminal Inductance, L_M	mH (nom)	2.96
Voltage, Stalled at Peak Torque, V_P	volts	37.4
Amps at Peak Torque, I_P	amps	260.619

MECHANICAL DIMENSIONS (INCHES)
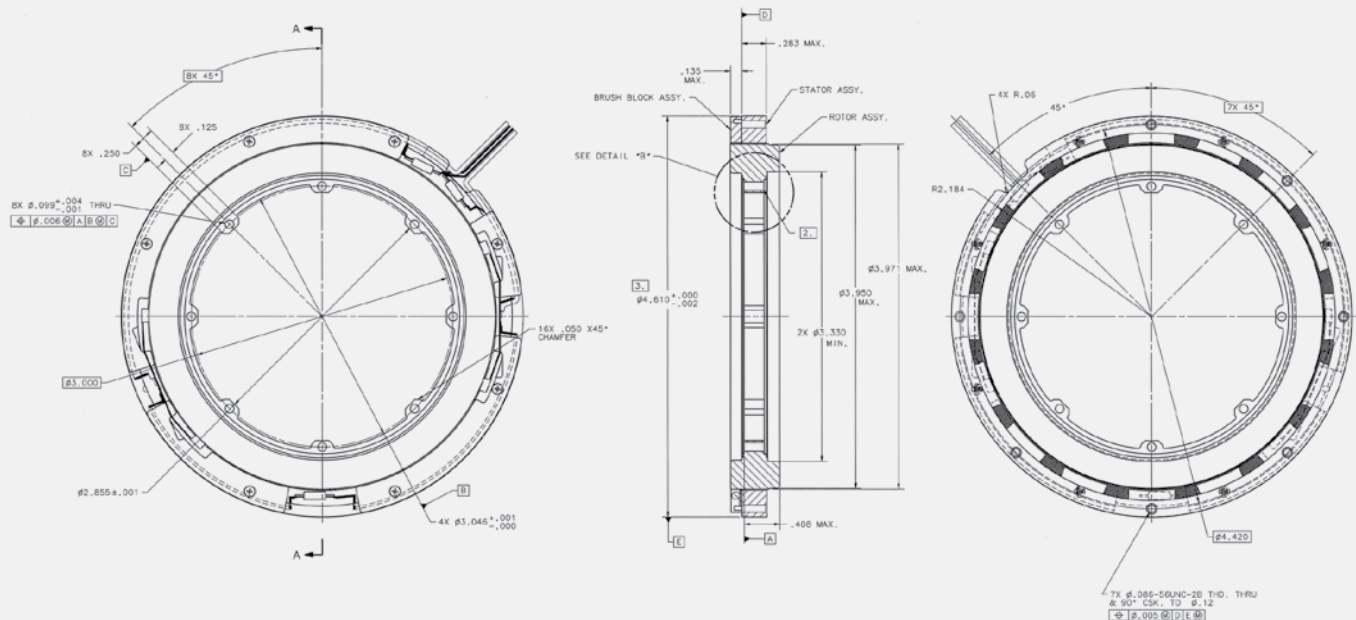
D-5125-C-3 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	160
Motor Constant, K_M	oz-in / $\sqrt{W}$	22.1
Number of Poles		16
Weight	oz (nom)	19
Motor Inertia, J_M	oz-in-s^2	9.80E-02
Friction Torque, T_F	oz-in	5
Electrical Time Constant, T_E	ms	0.447
Mechanical Time Constant, T_M	ms	28.31
Temperature Rise, TPR'	°C / W	4.5
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	48
Back EMF, K_E	V per rad/s	0.339
Terminal Resistance, R_M	ohms (nom)	4.70
Terminal Inductance, L_M	mH (nom)	2.1
Voltage, Stalled at Peak Torque, V_P	volts	15.7
Amps at Peak Torque, I_P	amps	3.33

MECHANICAL DIMENSIONS (INCHES)
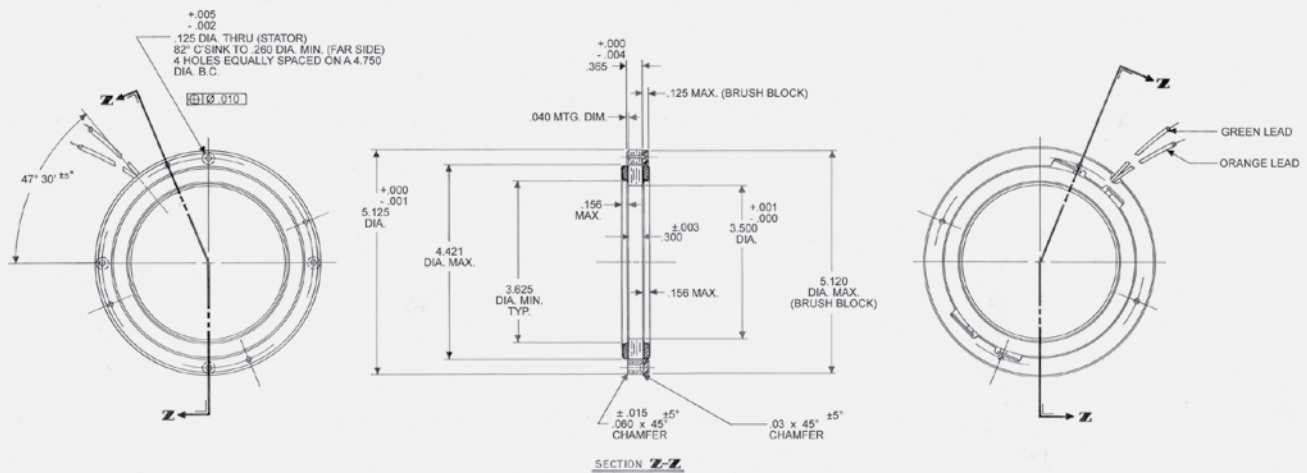
D-5600-A-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	15
Motor Constant, K_M	oz-in / $\sqrt{W}$	0.731
Number of Poles		14
Weight	oz (nom)	9.0
Motor Inertia, J_M	oz-in-s^2	4.40×10^{-3}
Friction Torque, T_F	oz-in	0.50
Electrical Time Constant, T_E	ms	1.6
Mechanical Time Constant, T_M	ms	6.1
Temperature Rise, TPR'	°C / W	1.2
Ripple Torque, T_R	max. avg. to peak (%)	6

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	1.15
Back EMF, K_E	V per rad/s	1.56
Terminal Resistance, R_M	ohms (nom)	2.49
Terminal Inductance, L_M	mH (nom)	4.1
Voltage, Stalled at Peak Torque, V_P	volts	32.4
Amps at Peak Torque, I_P	amps	13.0

MECHANICAL DIMENSIONS (INCHES)
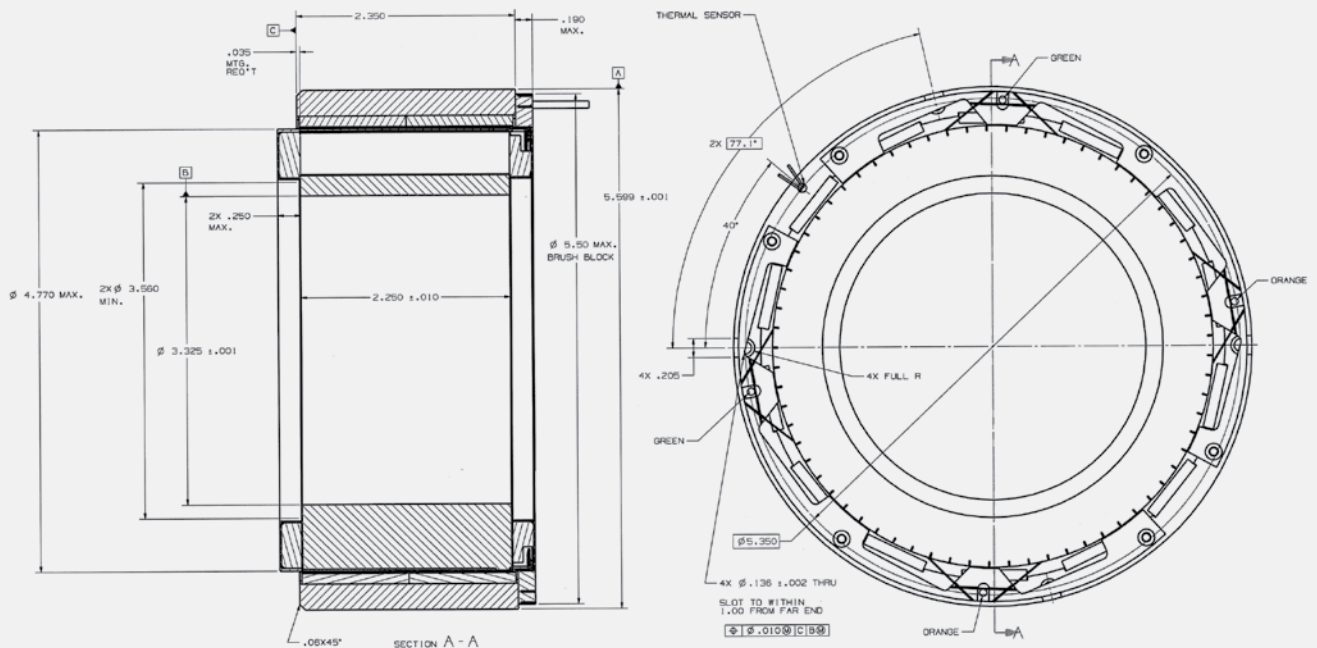
D-7200-A-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	27.6
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.10
Number of Poles		20
Weight	oz (nom)	12
Motor Inertia, J_M	oz-in-s^2	1.18×10^{-2}
Friction Torque, T_F	oz-in	0.35
Electrical Time Constant, T_E	ms	2.1
Mechanical Time Constant, T_M	ms	7.19
Temperature Rise, TPR'	°C / W	1.15
Ripple Torque, T_R	max. avg. to peak (%)	4

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	2.65
Back EMF, K_E	V per rad/s	3.59
Terminal Resistance, R_M	ohms (nom)	5.80
Terminal Inductance, L_M	mH (nom)	12
Voltage, Stalled at Peak Torque, V_P	volts	60.3
Amps at Peak Torque, I_P	amps	10.4

MECHANICAL DIMENSIONS (INCHES)
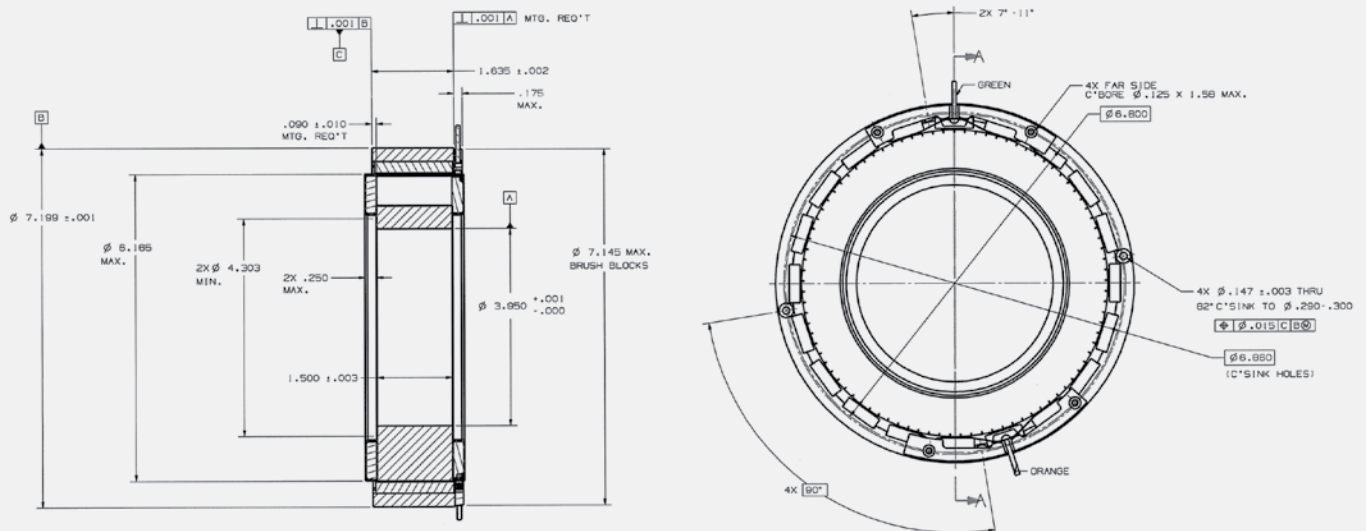
D-7200-B-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	42.3
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.73
Number of Poles		20
Weight	oz (nom)	24
Motor Inertia, J_M	oz-in-s^2	2.33×10^{-2}
Friction Torque, T_F	oz-in	0.60
Electrical Time Constant, T_E	ms	2.5
Mechanical Time Constant, T_M	ms	5.76
Temperature Rise, TPR'	°C / W	0.78
Ripple Torque, T_R	max. avg. to peak (%)	4

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	3.18
Back EMF, K_E	V per rad/s	4.31
Terminal Resistance, R_M	ohms (nom)	3.39
Terminal Inductance, L_M	mH (nom)	8.6
Voltage, Stalled at Peak Torque, V_P	volts	45.0
Amps at Peak Torque, I_P	amps	13.3

MECHANICAL DIMENSIONS (INCHES)

D-7200-C-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	43.3
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.70
Number of Poles		20
Weight	oz (nom)	22
Motor Inertia, J_M	oz-in-s^2	2.27×10^{-2}
Friction Torque, T_F	oz-in	0.60
Electrical Time Constant, T_E	ms	2.2
Mechanical Time Constant, T_M	ms	5.81
Temperature Rise, TPR'	°C / W	0.78
Ripple Torque, T_R	max. avg. to peak (%)	4

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	1.90
Back EMF, K_E	V per rad/s	2.57
Terminal Resistance, R_M	ohms (nom)	1.25
Terminal Inductance, L_M	mH (nom)	2.8
Voltage, Stalled at Peak Torque, V_P	volts	28.5
Amps at Peak Torque, I_P	amps	22.8

MECHANICAL DIMENSIONS (INCHES)

D-8630-C-1 SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	160
Motor Constant, K_M	oz-in / $\sqrt{W}$	22.1
Number of Poles		16
Weight	oz (nom)	37
Motor Inertia, J_M	oz-in-s^2	1.40E-02
Friction Torque, T_F	oz-in	8
Electrical Time Constant, T_E	ms	0.532
Mechanical Time Constant, T_M	ms	40.4
Temperature Rise, TPR'	°C / W	3
Ripple Torque, T_R	max. avg. to peak (%)	5

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	48
Back EMF, K_E	V per rad/s	0.339
Terminal Resistance, R_M	ohms (nom)	4.70
Terminal Inductance, L_M	mH (nom)	2.5
Voltage, Stalled at Peak Torque, V_P	volts	15.7
Amps at Peak Torque, I_P	amps	3.34

MECHANICAL DIMENSIONS (INCHES)
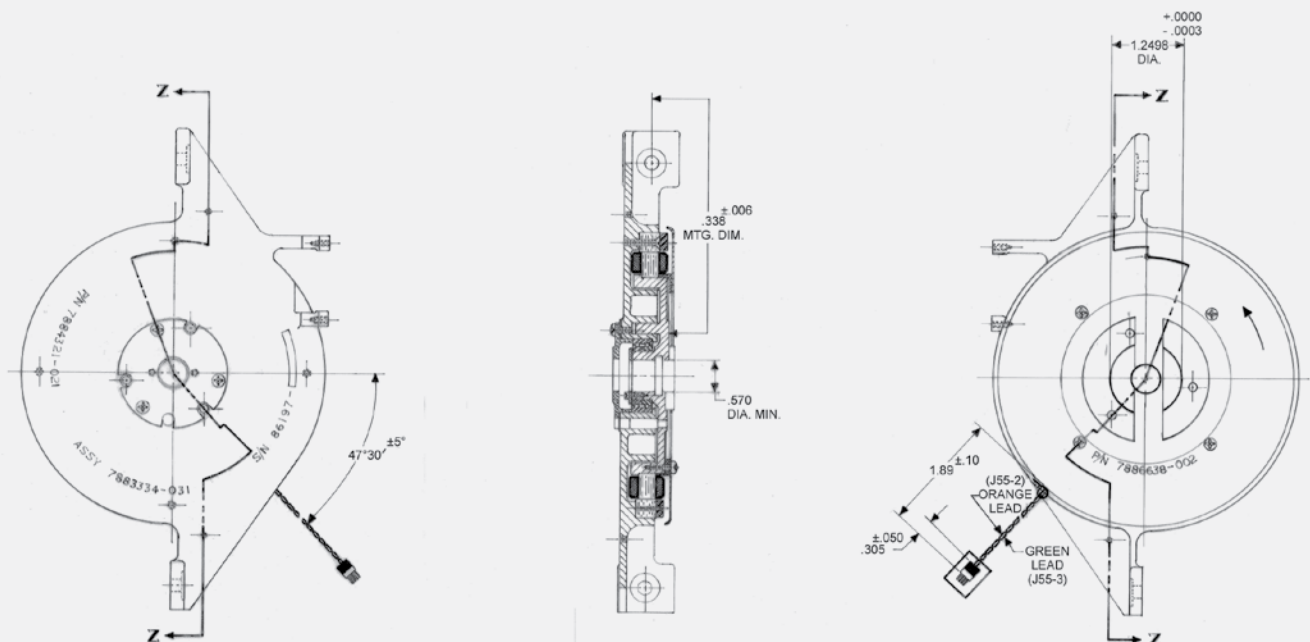
D-9000-A-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	46
Motor Constant, K_M	oz-in / $\sqrt{W}$	1.65
Number of Poles		24
Weight	oz (nom)	20
Motor Inertia, J_M	oz-in-s^2	2.80×10^{-2}
Friction Torque, T_F	oz-in	0.42
Electrical Time Constant, T_E	ms	2.9
Mechanical Time Constant, T_M	ms	7.17
Temperature Rise, TPR'	°C / W	0.89
Ripple Torque, T_R	max. avg. to peak (%)	4

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	3.71
Back EMF, K_E	V per rad/s	5.03
Terminal Resistance, R_M	ohms (nom)	4.78
Terminal Inductance, L_M	mH (nom)	14
Voltage, Stalled at Peak Torque, V_P	volts	59.3
Amps at Peak Torque, I_P	amps	12.4

MECHANICAL DIMENSIONS (INCHES)
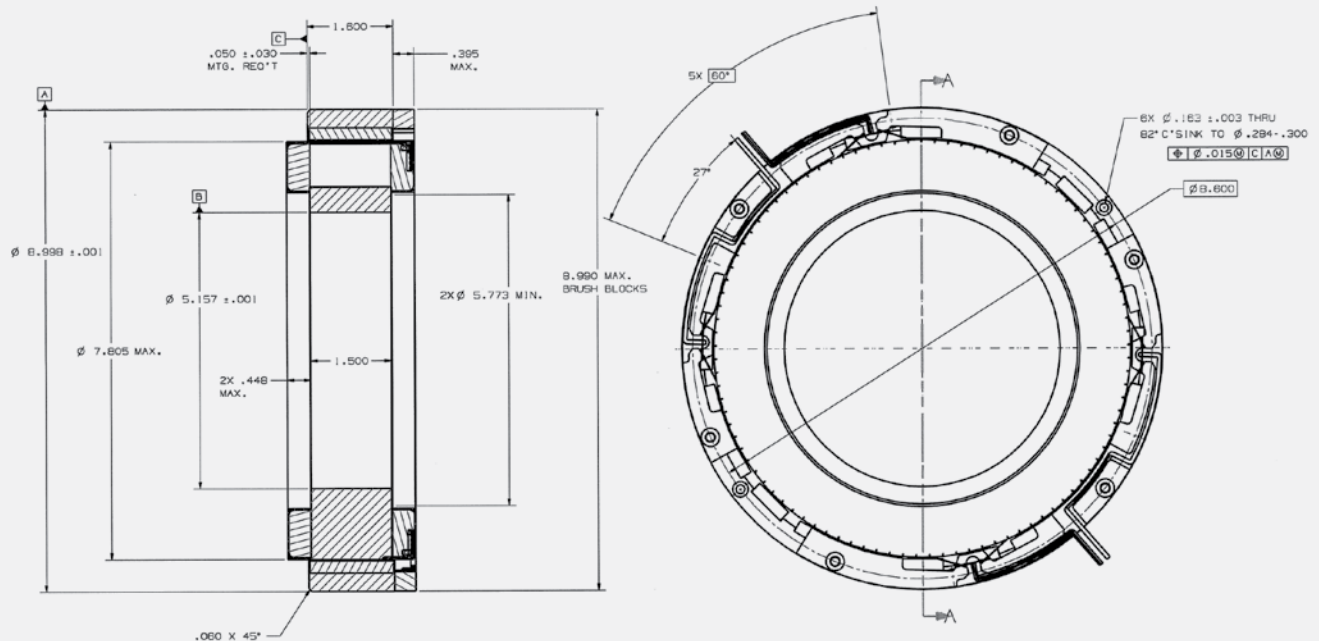
D-9000-B-1ES SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	60
Motor Constant, K_M	oz-in / √W	2.46
Number of Poles		24
Weight	oz (nom)	31
Motor Inertia, J_M	oz-in-s^2	4.10×10^{-2}
Friction Torque, T_F	oz-in	0.83
Electrical Time Constant, T_E	ms	3.6
Mechanical Time Constant, T_M	ms	5.00
Temperature Rise, TPR'	°C / W	0.68
Ripple Torque, T_R	max. avg. to peak (%)	4

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	6.22
Back EMF, K_E	V per rad/s	8.43
Terminal Resistance, R_M	ohms (nom)	6.40
Terminal Inductance, L_M	mH (nom)	23
Voltage, Stalled at Peak Torque, V_P	volts	61.8
Amps at Peak Torque, I_P	amps	9.65

MECHANICAL DIMENSIONS (INCHES)
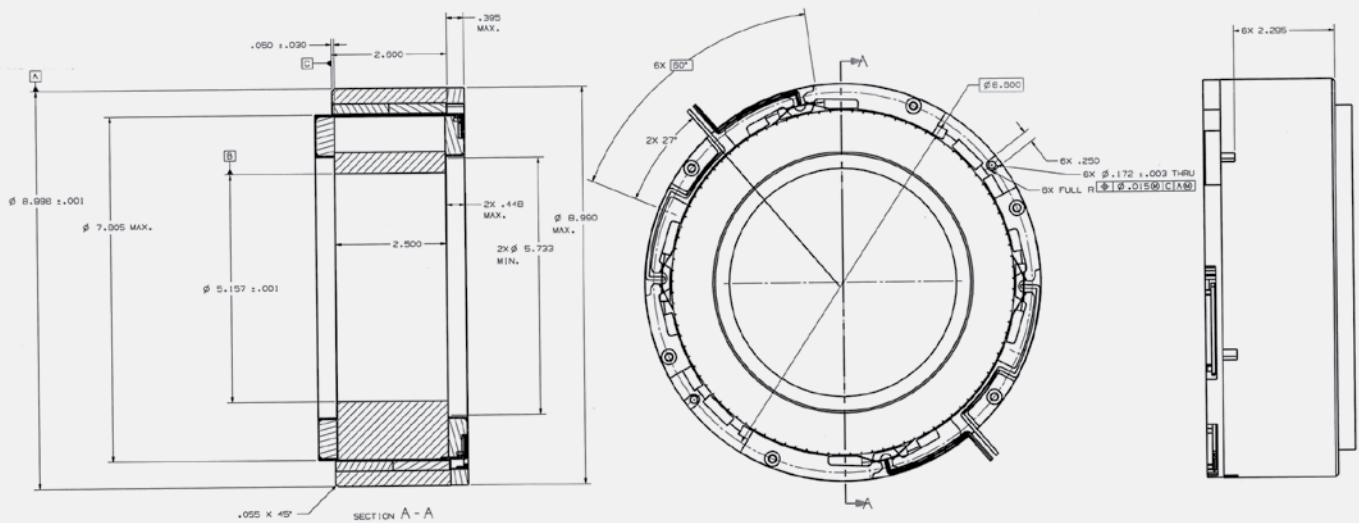
D-10020-C-1ANS SPECIFICATIONS

MOTOR CHARACTERISTICS @ 25° C

Specification	Units	Value
Peak Torque, T_P	oz-in	2222.3
Motor Constant, K_M	oz-in / $\sqrt{W}$	98.31
Number of Poles		32
Weight	oz (nom)	7.0
Motor Inertia, J_M	oz-in-s^2	1.335E+00
Friction Torque, T_F	oz-in	50.00
Electrical Time Constant, T_E	ms	0.443
Mechanical Time Constant, T_M	ms	19.561
Temperature Rise, TPR'	°C / W	1.96
Ripple Torque, T_R	max. avg. to peak (%)	7

MOTOR WINDING CONSTANTS

Specification	Units	Value
Torque Sensitivity, K_T	oz-in / amp	156.5
Back EMF, K_E	V per rad/s	1.105
Terminal Resistance, R_M	ohms (nom)	2.71
Terminal Inductance, L_M	mH (nom)	1.200
Voltage, Stalled at Peak Torque, V_P	volts	38.5
Amps at Peak Torque, I_P	amps	14.20

MECHANICAL DIMENSIONS (INCHES)
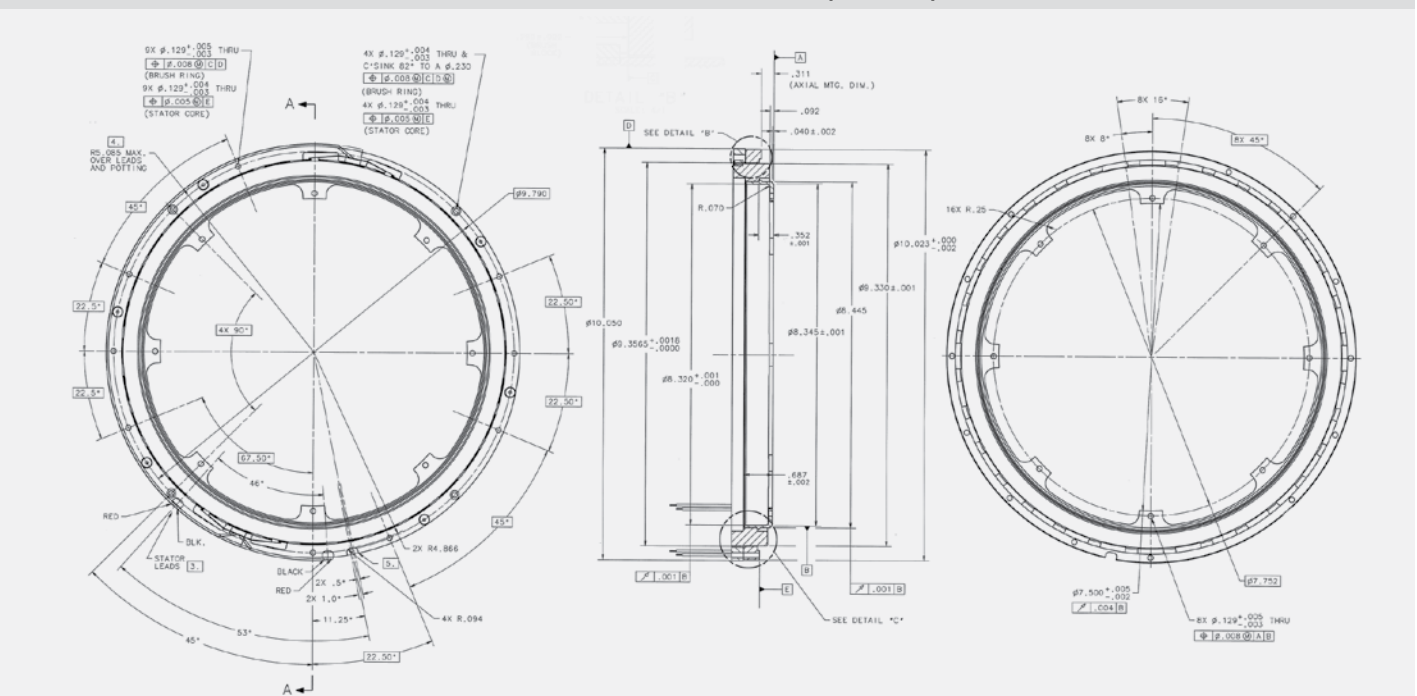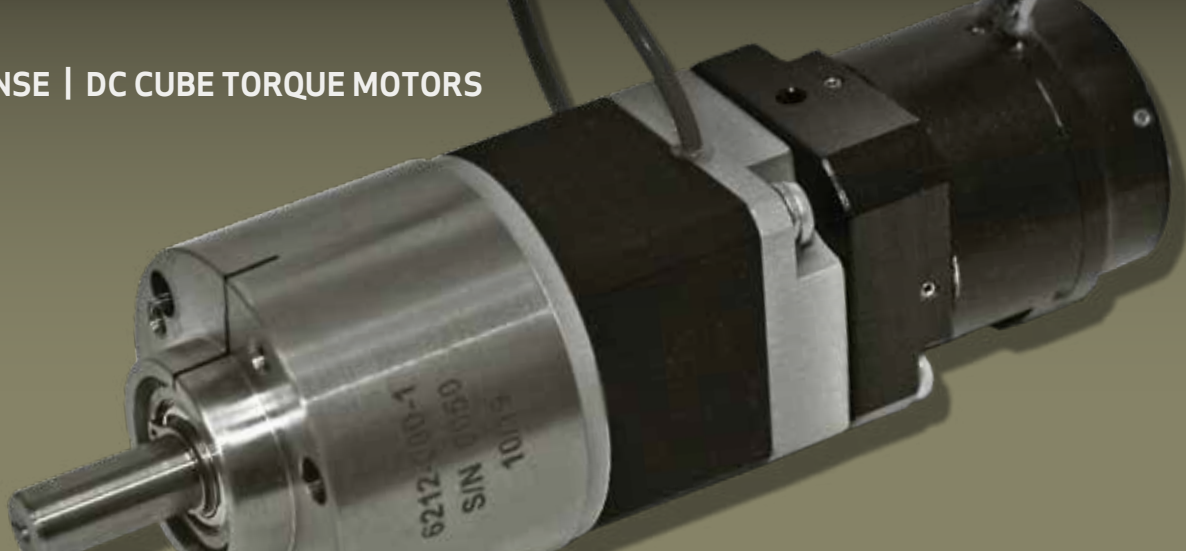
DC CUBE TORQUE MOTORS
21, 22, 23 AND SERIES

Moog's family of miniature permanent magnet DC cube torque motors is available in .075 and 1 inch frame sizes. These are rapid response motors at all operating speeds because of their high torque-to-inertia ratio and low self-inductance. Torque increases directly with input current for high linearity.

Cube motors are often used in applications where high torque is required, but the available space is limited. Cube motors lend themselves to easier mounting than cylindrical motors in many applications and are easier to lock into an envelope.

Moog offers a choice of Alnico or Samarium Cobalt magnet materials to satisfy most any requirement. These rare earth magnets produce a higher magnetic energy per unit volume than most commercially available permanent magnets. Alnico magnets provide enhanced temperature stability while Samarium Cobalt magnets offer high energy with good, stable performance.

We are tooled for hundreds of designs with different windings, end caps and other options including gearheads, brakes, resolvers, encoders and potentiometers. Most designs can easily be adapted to meet different requirements. We can also provide custom engineering services.

FEATURES

- 4 pole 13 bar motors – 2 brushes standard and
  4 brushes available
- Stainless steel shafts for durable, rugged wear
- Meets MIL-SPEC 810
- Standard nickel plated housing resists corrosion in
  harsh environments
- Peak torques from 1.0 to 20 oz-in
- Optional gearheads, brakes, resolvers, encoders and
  potentiometers available
- Available in 0.75 and 1 inch frame sizes
- Silver alloy brushes
- Speeds up to (7500) rpm
- Variety of windings available
- Gold plated terminals
- Gold alloy commutator
- Shaft can be modified with front and rear extensions,
  integrated gear or a pinio

BENEFITS

- High torque-to-inertia ratio in a small package
- Rapid response at all speeds
- Cartridge brush is easily field-replaceable
- Skewed rotors provide minimum cogging torque
- Gold-clad commutator for long life
- Rare earth magnets provide higher performance than
  standard permanent magnets
- Cubical shape provides weight and space savings and
  easy mounting
- Torque increases directly with input current for high linearity
  as a direct servo drive
- Low self inductance

CUBE MOTOR PARAMETERS

PART NUMBERING SYSTEM GUIDE

NN   NNN A — AA — NN / ANNN [ ]

DESIGN SERIES
(2 Numbers)

HOUSING TYPE
(3 Numbers)
Sequentially
assigned
by factory

SHAFT
(2 Letters)

ELECTRICAL OPTIONS
(2 Numbers)
Unique to design series

MODIFICATION NUMBER
"D" + 3 Numbers
Each modification number (slash
number) has a separate outline
modification sheet

HOUSING CODE
(Either Location)
P = Paladin black
S = Samarium Cobalt magnets
C = Connector

FRAME SIZE
21   1 inch square cube motor
22   1 inch square short version of series 21
23   1 inch square long version of series 21
24   .75 inch square cube motor

TERMINATIONS TYPE
(1 Letter)

A Solder eyelet terminals (pin type terminals, 2 leaf springs)
B Lead out the rear
C (Not used)
D Cover can and unshielded leads (radial exit)
E (Not used)
F (Not used)
G (Not used)
H (Not used)
I (Not used)
J Leads out the side
K Turret type terminals
L Screw terminals #4-40, side exit with cartridge brushes (4)
M Screw terminals #4-40, side exit with cartridge brushes (2)
N Pin type terminals with flush cartridge brushes (2)
O (Not used)
P (Not used)
Q Turret type terminals with flush (snap in) cartridge brushes (2)
R Leads out the side with flush (snap in) cartridge brushes (2)
S (Not used)
T (Not used)
U 4 leaf springs, 2 pin terminals, 2 leads
V Pin type terminals with flush (snap in) cartridge brushes (4)
W Leads out the side with flush (snap in) cartridge brushes (4)
X 4 cartridge brushes, 2 pin terminals, 2 leads
Y #2-64 screw terminals, 180° apart
Z 4 leaf springs, 4 pin terminals

EXAMPLES OF TYPICAL CUBE MOTORS

1.21 Cube Series
- 1.02 in x 1.02 in x 1.069 in max
- 1.355 in x 1.355 in x 1.02 in max - cartridge screw type
- Peak Torques: 7.6 oz-in Alnico magnet
          15.0 oz-in Samarium Cobalt magnet

2.22 Cube Series
- 1.02 in x 1.02 in x 0.812 in max
- Peak Torques: 3.6 oz-in Alnico magnet
          7.0 oz-in Samarium Cobalt magnet

3.23 Cube Series
- 1.02 in x 1.02 in x 1.343 in max
- 1.355 in x 1.355 in x 1.500 in max - cartridge screw type
- Peak Torques: 12.0 oz-in Alnico magnet
          20.0 oz-in Samarium Cobalt magnet

4.24 Cube Series
- 0.750 in x 0.750 in x 0.750 in max
- Peak Torques: 2.7 oz-in Alnico magnet
          (2.7) oz-in Samarium Cobalt magnet

TYPICAL APPLICATIONS

- Avionics - cockpit instrumentation (altitude,
  latitude) and displays (indicators and instruments)
- Robotic control systems
- Military targeting / fire control systems
- Sighting systems
- Missiles
- Military actuators
- Direct drive servo systems
- Medical equipment

Integrated Motion Technology

In many gimballed systems for the military, aerospace and industrial market segments, rotary electromechanical components such as motors, resolvers and slip ring assemblies often find themselves sharing common envelopes and structures. For this reason, Moog has a unique niche in the marketplace by providing and integrating these traditional components into one assembly so the individual components have been optimized to work together.

Today, Moog is in the unique position to provide engineering and manufacturing expertise for all rotary components that share the gimbal's structure. Moog's fractional horsepower DC motors provide the torque for continuous rotation for scanning applications such as radar, missiles, seekers, aerial targets and target acquisition systems while the slip ring assemblies pass the power and data across the rotating interface. Our resolvers provide the positional feedback often within arc seconds of accuracy.

These components can, of course, be provided separately or be integrated. Integrated products typically share a common structure and bearing which reduces piece part count and system weight. Integration and test is performed at the factory providing a "plug and play" subsystem. Moog also provides complete actuator systems with control electronics. This integrated concept reduces the number of items that would otherwise have to be procured and stocked by the OEM.

System enhancements and upgrades occur naturally when dealing with one company that has the engineering and manufacturing expertise for rotary component needs.

SPECIFICATIONS ON TYPICAL CUBE MOTORS

The following tables presents a cross-section of Moog cube motor designs. Tooling charges may apply to new designs.

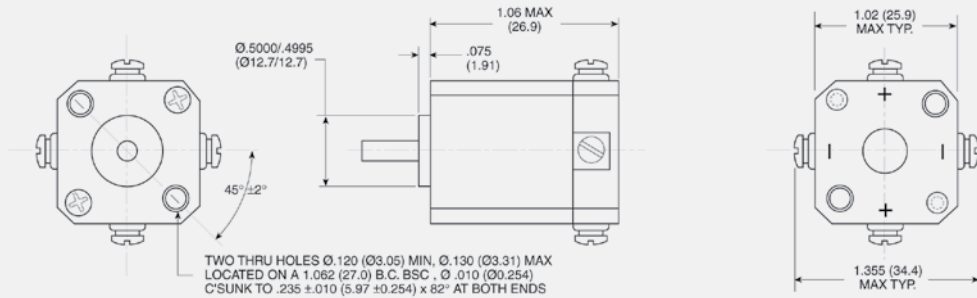| Part Number	Length inches (metric)	Peak Torque (oz-in) (Nm)	Volts at Peak Torque (Volts)	Current at Peak Torque (amps)	Torque Constant (oz-in/amp)	Back EMF (V/rad/sec) x10E−2 (Nm/amp)	DC Resistance (Ohms)	Inductance (mH)	Inertia (oz-in-sec2) x10E−4 (KgCm2 x10E−4)	No Load Speed (RPM)	No Load Current (Ma)	Starling Voltage (Volts)	Weight (oz) (gm)
21105N-□□-03	1.06	7.5	26.0	1.7	5.3	3.74	15.0	6.0	1.3	6500	85	1.0	2.93
	26.9	.053	26.0	1.7	.037	3.74	15.0	6.0	.018	6500	85	1.0	83.06
21105A-□□-04	1.06	7.5	41.7	0.975	7.55	5.3	44.0	16.0	1.3	6500	60	0.75	2.93
	26.9	.053	41.7	0.975	.053	5.3	44.0	16.0	.018	6500	60	0.75	83.06
21105N-□□-08	1.06	8.6	13.0	3.3	2.6	1.8	3.9	1.3	1.3	6500	150	1.0	2.93
	26.9	.061	13.0	3.3	.018	1.8	3.9	1.3	.018	6500	150	1.0	83.06
21105N-□□-10	1.06	6.0	8.0	5.0	1.2	0.85	1.6	0.4	1.3	6500	225	1.0	2.93
	26.9	.042	8.0	5.0	.009	0.85	1.6	0.4	.018	6500	225	1.0	83.06
21105N-□□-12	1.06	6.5	26.0	1.7	4.6	3.25	15.0	6.0	1.3	7000	85	1.0	2.93
	26.9	.046	26.0	1.7	.033	3.25	15.0	6.0	.018	7000	85	1.0	83.06
21105N-□□-13	1.06	6.5	41.7	0.975	6.7	4.8	44.0	16.0	1.3	7000	60	1.0	2.93
	26.9	.046	41.7	0.975	.048	4.8	44.0	16.0	.018	7000	60	1.0	83.06
21605A-□□-14S	1.06	11.0 min.	20.5	2.95	3.8	2.68	7	3.3	1.3	7000	217	1.0	2.93
	26.9	.078	20.5	2.95	.027	2.68	7	3.3	.018	7000	217	1.0	83.06
21607A-□□-15S	1.06	12.0 min.	24	3.5	4.75	3.35	7.5	3.5	1.3	6500	90	0.75	2.93
	26.9	.85	24	3.5	.034	3.35	7.5	3.5	.018	6500	90	0.75	83.06
21607J-□□-16S	1.06	8.5	20	1.5	5.5	3.9	13	5	1.3	4600	100	1.5	2.93
	26.9	.060	20	1.5	.039	3.9	13	5	.018	4600	100	1.5	83.06
21607J-□□-19S	1.06	12.0	25.9	2.9	5.0	3.5	9	4	1.3	6800	60	1.0	2.93
	26.9	.085	25.9	2.9	.035	3.5	9	4	.018	6800	60	1.0	83.06
21605A-□□-20S	1.06	12.0	28	3.2	5.4	3.8	10.5	5	1.3	6700	60	0.75	2.93
	26.9	.085	28	3.2	.038	3.8	10.5	5	.018	6700	60	0.75	83.06
21105K-□□-22S	1.06	7.2	12	2.1	4.5	3.2	7	3.3	1.3	3400	60	1.0	2.93
	26.9	.051	12	2.1	.032	3.2	7	3.3	.018	3400	60	1.0	83.06
22613J-□□-01	0.812	3.6	26.0	0.6	6.0	4.2	43.0	12.0	0.65	5000	45	1.0	2.0
	20.6	.025	26.0	0.6	.042	4.2	43.0	12.0	.009	5000	45	1.0	56.70
22613M-□□-01	0.812	3.6	26.0	0.6	6.0	4.2	43.0	12.0	0.65	5000	45	1.5	2.0
	20.6	.025	26.0	0.6	.042	4.2	43.0	12.0	.009	5000	45	1.5	56.70
23101L-□□-01	1.50	10.0	26.0	2.1	4.8	3.4	12.0	5.0	2.2	5800	125	1.0	4.3
	38.1	.071	26.0	2.1	.034	3.4	12.0	5.0	.031	5800	125	1.0	121.9
23101L-□□-02	1.50	12.0	18.0	3.27	3.7	2.6	5.5	2.2	2.2	5500	175	1.0	4.3
	38.1	.085	18.0	3.27	.026	2.6	5.5	2.2	.031	5500	175	1.0	121.9
24618R-□□-04	0.75	1.7	15.0	0.58	3.7	2.6	26.0	8.5	0.35	5000	50	1.5	1.25
	19.1	.012	15.0	0.58	.026	2.6	26.0	8.5	.005	5000	50	1.5	35.44
24618N-□□-05	0.75	2.7	12.0	1.0	2.7	1.9	12	—	0.35	5725	50	1.0	1.25
	19.1	.019	12.0	1.0	.019	1.9	12	—	.005	5725	50	1.0	35.44
24618R-□□-09	0.75	1.0	6	0.75	1.35	0.95	8	1.4	0.35	6000	125	1.0	1.25
	19.1	.007	6	0.75	.010	0.95	8	1.4	.005	6000	125	1.0	35.44
24618V-□□-10	0.75	2.5	26	0.425	5.75	4.1	61	—	0.35	5500	30	1.0	1.25
	19.1	.018	26	0.425	.041	4.1	61	—	.005	5500	30	1.0	35.44
24618V-□□-11	0.75	1.5	15.0	0.555	2.7	1.9	22.5	—	0.35	6600	75	1.25	1.25
	19.1	.011	15.0	0.555	.019	1.9	22.5	—	.005	6600	75	1.25	35.44
24618V-□□-15	0.75	1.0	7.5	0.575	1.8	1.3	13	1.4	0.35	5000	70	0.75	1.25
	19.1	.007	7.5	0.575	.013	1.3	13	1.4	.005	5000	70	0.75	35.44

Part Number	Length (inches)	Peak Torque (oz.-in.)	Volts at Peak Torque (Volts)	Current at Peak Torque (amp)	Torque Constant (oz.in./amp)	Back EMF (V/Rad./s)	Term. Res. (Ohms)	Term. Ind. (mH)	Rotor Inertia (oz.in.s²)	Frictional Torque (oz.in.)	Motor Constant (oz.in./sq.rt.watts)	Weight (oz.)	(Commutation)	Pot. End-End Travel	Pot. Linearity
DC MT/POT AS-889-003	1.500	12.0	21.6	2.40	5.00	0.035	9.00	4.50	1.6E-04	0.30	1.67	4.0	Potentiometer	250°	Absolute +/- .50%
MT/RESOLVER AS-891-002	2.000	1.3	13.3	0.42	3.50	0.025	32.00	6.00	7.8E-06	0.20	0.62	3.2	Resolver	Accuracy < 6'	Transformation Ratio 0.454 +/- 5%
MT/POT/GHD AS-915-001	3.375	66.5	26.1	2.90	5.50	0.039	9.00	4.50	3.0E-04	3.50	1.83	6.0	None	Gear Ratio 4.84:1	Back Lash < 0.5°

CUBE MOTOR TYPICAL OUTLINES
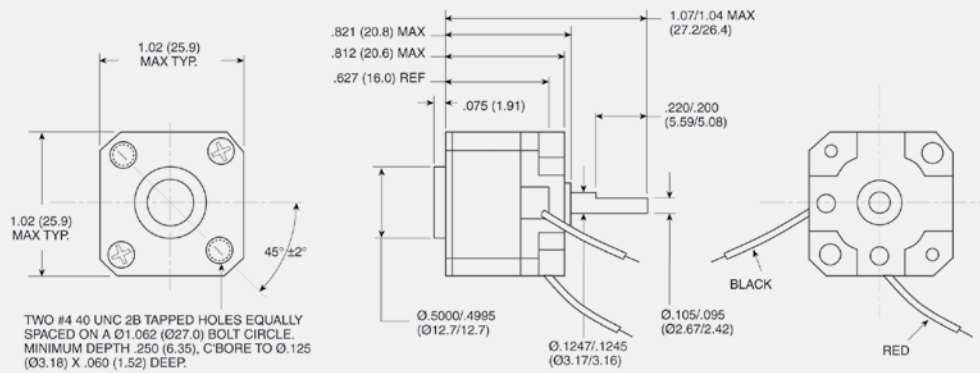
MECHANICAL DIMENSIONS IN INCHES (MILLIMETERS)

21 SERIES (21105L-☐☐-08)

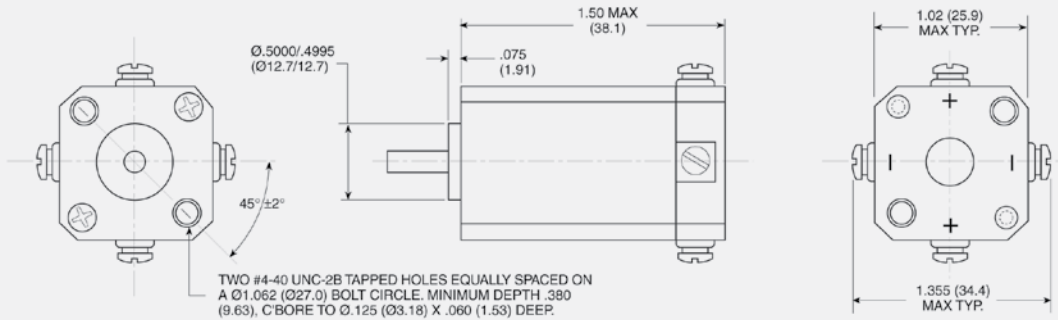Standard 1 inch cube motor with cartridge brushes and screw terminals

Ø.5000/.4995 (Ø12.7/12.7)

1.06 MAX (26.9)

.075 (1.91)

1.02 (25.9) MAX TYP.

45°±2°

1.355 (34.4) MAX TYP.

TWO THRU HOLES Ø.120 (Ø3.05) MIN, Ø.130 (Ø3.31) MAX LOCATED ON A 1.062 (27.0) B.C. BSC , Ø .010 (Ø0.254) C'SUNK TO .235 ±.010 (5.97 ±0.254) x 82° AT BOTH ENDS

22 SERIES (22613R-HP-01 / D358)

Short 1 inch cube motor with cartridge brushes and lead wires

1.02 (25.9) MAX TYP.

1.02 (25.9) MAX TYP.

45°±2°

.821 (20.8) MAX
.812 (20.6) MAX
.627 (16.0) REF

.075 (1.91)

1.07/1.04 MAX (27.2/26.4)

.220/.200 (5.59/5.08)

Ø.5000/.4995 (Ø12.7/12.7)

Ø.1247/.1245 (Ø3.17/3.16)

Ø.105/.095 (Ø2.67/2.42)

BLACK

RED

TWO #4 40 UNC 2B TAPPED HOLES EQUALLY SPACED ON A Ø1.062 (Ø27.0) BOLT CIRCLE. MINIMUM DEPTH .250 (6.35), C'BORE TO Ø.125 (Ø3.18) X .060 (1.52) DEEP.

23 SERIES (23101L-☐☐-02)

Long 1 inch cube motor with cartridge brushes and screw terminals

Ø.5000/.4995 (Ø12.7/12.7)

1.50 MAX (38.1)

.075 (1.91)

1.02 (25.9) MAX TYP.

45°±2°

1.355 (34.4) MAX TYP.

TWO #4-40 UNC-2B TAPPED HOLES EQUALLY SPACED ON A Ø1.062 (Ø27.0) BOLT CIRCLE. MINIMUM DEPTH .380 (9.63), C'BORE TO Ø.125 (Ø3.18) X .060 (1.53) DEEP.

24 SERIES (24618X-☐☐-04)

3/4 inch cube motor

.750 (19.05) MAX TYP.

.750 (19.05) MAX TYP.

45°±2°

.750 (19.05) MAX
.601 (15.3) REF
.059/.050 (1.50/1.27)

.220(5.59)

.125 (3.18) MAX TYP.

RED

BLACK

Ø.3125/.3122 (Ø7.94/7.93)

Ø.024/.022 TYP (Ø0.601/0.559)

TWO THRU HOLES, Ø .100/.094 (Ø2.54/2.34), EQUALLY SPACED ON A .800 (20.32) B.C.

LEADS TYPE "ET" TEFLON INSULATED #30 AWG PER MIL-W 16878/6 12" MINIMUM LENGTH
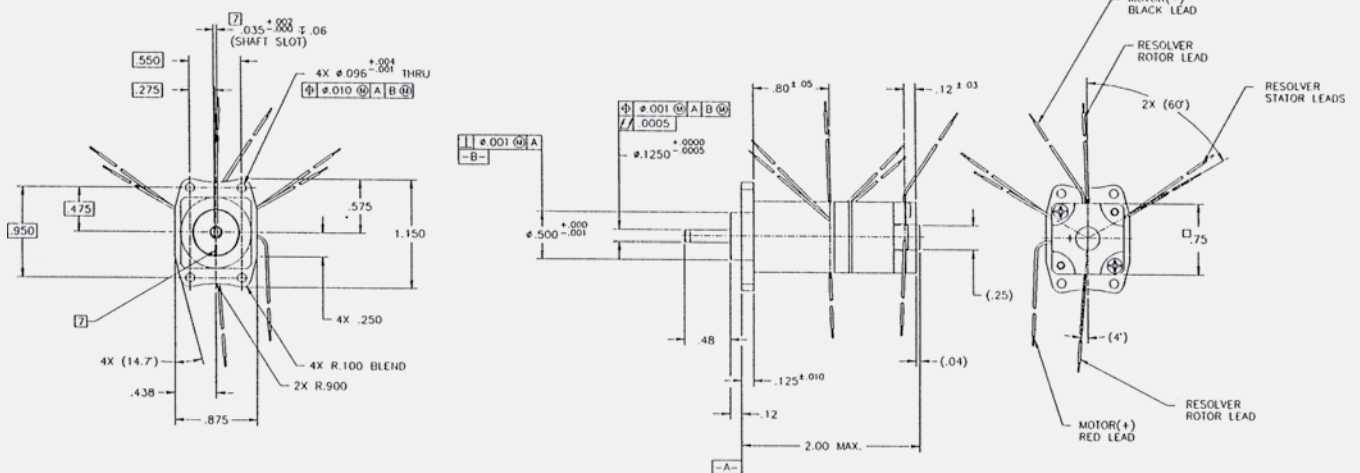
CUBE MOTOR OUTLINES

CUBE MOTOR WITH POTENTIOMETER AND BRAKE
Part# AS-890-001
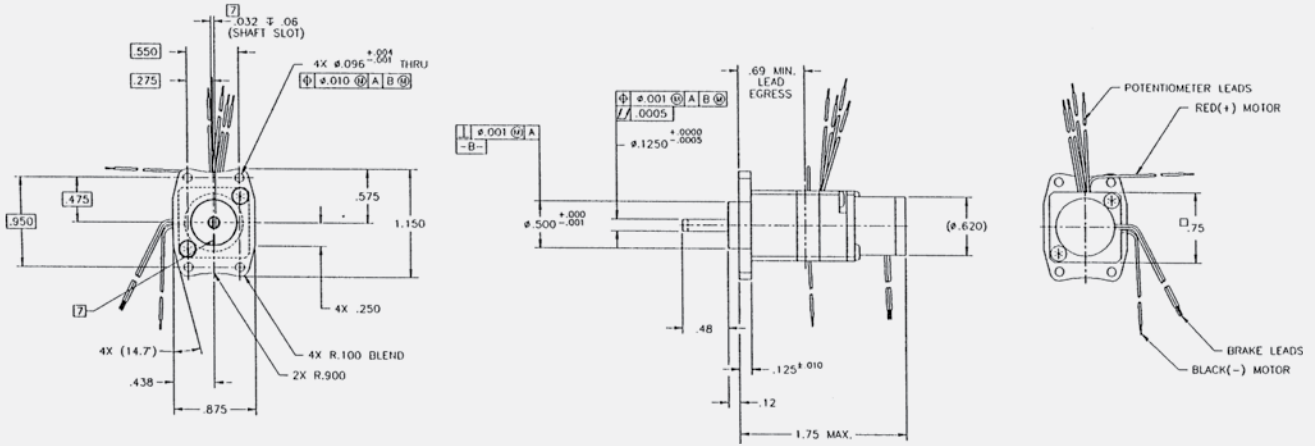
CUBE MOTOR WITH A GEARHEAD
Part# AS-798Q-002
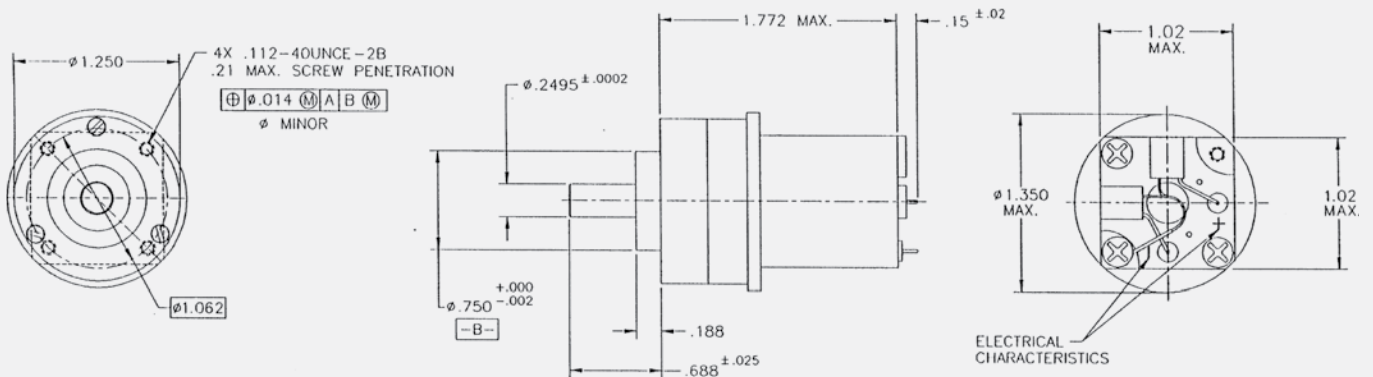
CUBE MOTOR WITH A RESOLVER
Part# AS-891-001

MILITARY / AEROSPACE RESOLVERS
FOR POSITION, COMMUTATION, AND VELOCITY FEEDBACK

Resolvers provide accurate position and velocity feedback as well as commutation in precision equipment, without the structural or temperature restrictions imposed by other electronic feedback devices. They are resistant to the shock and vibration levels often encountered in military and aerospace applications.

These resolvers are available in standard sizes, or with custom modifications. Our engineering department is available for consultation to help tailor a resolver to fit your needs.

FEATURES

- 1, 2, 4, 8, 16, 32 and 36 speeds standard; others available
- 400 – 5,000 Hz frequency range standard; frequencies up to 20,000 Hz available
- High immunity to electrical noise
- Rugged design to meet demanding environments – no glass discs or optics to fail
- Compact design
- Mounts directly to shaft and housing – no coupling devices needed
- Brush or brushless designs
- High reliability – long-life design; no bearings or electronics
- Custom modifications available

INTEGRATION CAPABILITIES

- Ideal for vertical integration with brushless motors and slip ring assemblies
- Commutation of brushless motors
- Feedback sensor for servo systems
- Compatible with R / D converters

TYPICAL APPLICATIONS

Where precise position indication is required to interface with resolver to digital converters.

- Target acquisition systems
- Gun trunnions
- Forward-Looking-Infra-Red (FLIR) systems
- Electro-optical systems
- Radar systems
- Missile seekers
- Motor commutation

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MECHANICAL PARAMETERS AND SCHEMATICS OF RESOLVERS

TYPES OF RESOLVERS

Pancake Resolvers

Pancake resolvers are so named for their physical dimensions – they typically have a diameter that exceeds their axial length. Pancake resolvers are supplied as separate rotor and stator assemblies, which are then mounted directly in the user's system. They are often supplied with a custom ring on the stator and hub on the rotor which facilitate mounting in the user's system. This also improves performance in the operating temperature ranges typically found in military systems. Figure A shows a typical physical configuration for a pancake resolver with a ring and hub.

A pancake resolver can also be supplied in a multispeed configuration. Multispeeds are mechanically and electrically similar to a standard pancake, but produce "N" cycles of electrical output for each mechanical revolution of the rotor. "N" is called the ratio or speed of the resolver. For example, an 8 speed resolver has one electrical output cycle in 360/8 = 45 degrees of mechanical rotation. The individual electrical cycles can be distinguished from each other by inserting a single speed in the same slots with the multispeed, creating a multiple speed unit. Figures B and C below show typical wiring schematics for single speed and multispeed resolvers, respectively. Mounting diameters A and B and overall thickness C (refer to Figure A) as well as electrical parameters for a variety of units are tabulated on page 194.

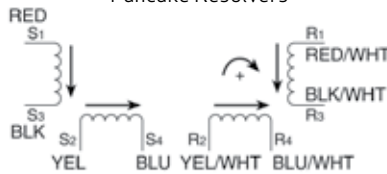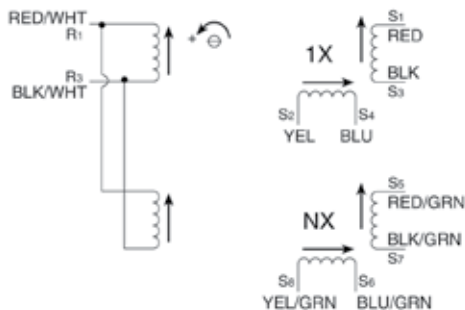**Figure A.** Dimension Configuration for Single or Multispeed Unhoused Pancake Resolvers

Brushless Pancake Resolvers

A rotary transformer can be added to a pancake resolver so that all of the leads exit from the stationary element. Since the rotor is energized through this rotary transformer, slip rings and brushes are not required in the user's system. This type of resolver is called a brushless pancake resolver and is designated as "B/L" in the function column in the table on page 194. Figure E below shows a typical wiring schematic for a brushless resolver. Brushless resolvers often offer a less costly and more reliable alternative to resolvers that are energized through slip rings.

Housed Resolvers

A pancake resolver can be mounted in a housing and shaft configuration that includes a set of ball bearings. Usually, the resolver housing is hard-mounted to the stationary portion of the user's system and the resolver shaft is connected to the rotating portion through a torsionally rigid flexible connector such as a bellows coupler. A housed resolver such as this can also incorporate a rotary transformer. A typical outline for a housed, brushless resolver is shown in Figure D. Often, a housed resolver will be more accurate than an equivalent unhoused unit because the air gap of the resolver can be ground concentric with the bearing seats.
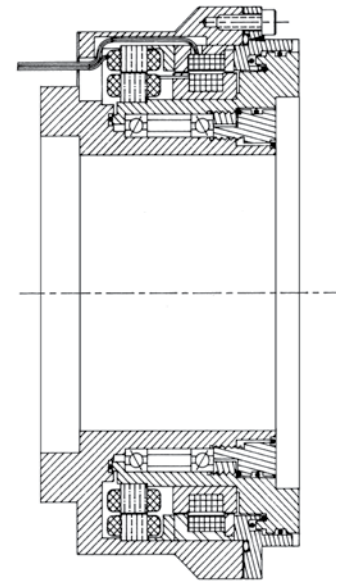
Figure D. Typical Outline for Housed Resolvers

Our engineering department is available to assist you in obtaining a mechanical configuration that will fit your system's requirements.

Figure B. Typical Schematic for Single Speed Pancake Resolvers

Figure C. Typical Schematic for Multispeed Pancake Resolvers

Figure E. Schematic and Phasing Equation of Typical Transformer Type Resolvers

$E(S_{13}) = N[E(R_{13}) \cos a]$
$E(S_{24}) = N[E(R_{13}) \sin a]$
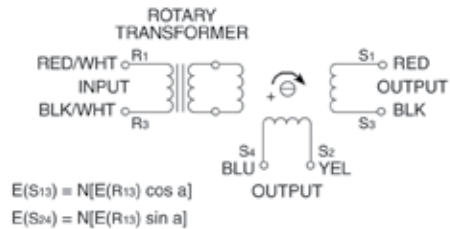
MILITARY / AEROSPACE RESOLVERS

										SPECIFICATIONS					

Part Number	Function	Primary Winding	Speed	Input (Volts/Hz)	Max Error (Accuracy) (+/-)	Trans. Ratio	Phase Shift (DEG)	Max Null V (mV)	Pin (mW)	Impedances Zpo	Impedances Zso	A OD	B ID	C Overall Width	Notes
SSH-12-M-1	RES RX	R	1X	10/3200	6'	1.0	8	20	46	200+j630	330+j830	1.187	0.563	0.328	4
SMH-12-A-3	RES RX	R	3X	5/4800	2'	0.38	30	15	64	111+j198	33+j60.5	1.187	0.563	0.365	4
SMH-14-A-1	RES RX	R	4X	26 / 500	6'	0.454	32	15	60	320 + j640	620 + j440	1.31	0.187	0.465	3
SMH-16-J-1	RES RX	R	2X	26 / 400	3'	0.454	40	20	814	350 + j410	157 + j165	1.56	0.81	0.38	3
SMH-17-B-3	RES RX	R	4X	26 / 500	6'	0.454	32	15	60	320 + j640	620 + j440	1.66	0.156	0.54	3
SSH-23-S-1	RES RX	S	1X	26 / 400	10'	0.454	30	30	225	900 + j1380	320 + j480	2.29	0.32	0.408	3
SMH-32-D-1	RES RX	R	16X	7 / 12500	60"	0.286	4	30	75	660	60 + j110	2.850	1.745	0.530	3
SMH-30-B-1	RES RX	R	16X	15 / 1200	30"	0.5	23	15	370	100 + j225	540 + j475	2.94	1.5	0.708	3
SMH-30-C-1	RES RX	R	8X	15 / 1200	1'	0.5	15	20	125	120 + j450	600 + j575	2.94	1.5	0.708	3
SMH-30-E-1	RES RX	S	16X	26 / 1440	30"	0.454	45	30	240	502 + j1098	935 + j1398	2.960	0.740	0.550	3
SMH-34-G-1	RES RX	S	8X	26 / 1440	30"	0.454	17.5	30	460	155 + j455	300 + j200	3.34	1.075	0.55	3
SMH-34-C-1	RES RX	R	8X	26 / 2400	2'	0.454	42	20	1200	206 + j358	——	3.39	0.875	0.914	3
SSJH-36-B-3/ P195	RES RX	R	1X and 16X	26 / 400	15' / 1'	0.454 / 0.454	8 / 25	30 / 20	530	225 + j480	750 + j225 / 460 + j460	3.57	2	0.6	1, 3
SSJH-36-K-1	RES RX	R	1X and 8X	26 / 2400 / 26 / 2400	10' / 1'	0.454 / 0.454	4 / 13	20 / 20	40 / 140	4000 + j8800 / 200 + j890	—— / ——	3.58	1.31	1.11	3
SMH-37-A-3	RES RX	R	8X	11.8 / 400	1'	0.4	27	10	60	650 + j1270	——	3.61	0.54	0.61	3
SMH-37-J-1	RES RX	R	16X	26 / 400	30"	0.454	29	25	600	330 + j540	——	3.61	0.728	0.65	3
SSJH-37-J-4	RES RX	R	1X and 32X	8 / 2400	60' / 20"	0.25 / 0.25	2.5 / 35	15 / 5	150	180 + j306	81 + j48 / 150 + j172	3.610	.728	.650	1, 3
SMH-43-E-1	RES RX	S	16X	7 / 12500	60"	0.286	2.5	30	54	51 + j206	51 + 250 MΩ	3.695	2.405	0.530	3
SSBH-40-C-1	B/L R RX	S	1X	7 / 1200	6'	0.683	3	15	65	180 + j320	313 + j487	3.95	2	1	3
SSJH-43-C-1	RES RX	R	1X and 16X	7 / 4500 / 7 / 4500	15' / 60"	0.454 / 0.454	0 / 4.5	30 / 15	16	122 + j686	530 + j545	4.245	3.175	0.545	4
SMVH-44-A-2	RES VR	S	2X	12 / 5000	2°	0.275	12	40	3125	32 + j120	42 + j245	4.4	0.945	0.65	3
SSJH-46-C-1	RES RX	R	1X and 16X	7 / 800 / 7 / 800	10' / 30"	0.357 / 0.345	10 / 35	6 / 4	3 / 225	1650 + j5040 / 61 + j97	295 + j725 / 80 + j39	4.52	2.08	0.578	3
SSH-50-B-1	RES RX	R	1X	26 / 400	3'	0.454	3	25	120	1435 + j2530	360 + j565	4.99	3.456	0.7	4
SSJH-50-B-3	RES RX	R	1X and 32X	26 / 2600 / 26 / 2600	15' / 20"	0.454 / 0.454	4 / 11.5	25 / 25	282	162 + j602	278 + j295 / 265 + j1060	4.994	3.456	0.750	4
SMH-53-A-1	RES RX	R	2X	18 / 400	5'	0.656	45	18	50	760 + j1400	780 + j855	5.26	2.385	0.855	3
SSJH-60-A-1	RES RX	R	1X and 32X	26 / 400	10' / 20"	0.454 / 0.454	10 / 23	25 / 30	670	145 + j352	—— / ——	6	3.455	1	1, 4
SSJH-60-D-1	RES RX	R	1X and 16X	115 / 400 / 115 / 400	20' / 40"	0.783 / 0.783	5 / 18	200 / 200	330 / 3,200	7978 + j17680 / 560 + j1668	5100 + j12228 / 2216 + j2380	6	3.455	1	4
SSJH-63-A-1	RES RX	R	1X and 16X	26 / 400	15' / 60"	0.454 / 0.454	21 / 36	30 / 15	1570	152 + j203	730 + j255 / 400 + j250	6.25	5.01	0.61	1, 4
SGH-78-B-2	SYN CX	R	1X	26 / 400	4'	0.454	20	30	500	2480 + j3285	720 + j885	7.75	4.27	1.88	3
SGH-78-C-2	SYN CX	R	1X	26 / 401	4'	0.454	20	30	500	2480 + j3285	720 + j885	7.75	4.27	1.88	3
SGH-78-D-2	SYN CX	R	1X	26 / 402	4'	0.454	20	30	500	2480 + j3285	720 + j885	7.75	4.27	1.88	3
SSJH-98-A-1	RES RX	R	1X and 16X	26 / 400 / 26 / 400	10' / 60"	0.450 / 0.450	7 / 9.3	30 / 30	120 / 180	2080 + j2700 / 130 + j690	535 + j750 / 265 + j280	9.750	6.000	1.000	3

Abbreviations:

Function: RES RX = Resolver Transmitter
 SYN CX = Synchro Transmitter
 B/L R RX = Brushless Resolver Transmitter

Winding: R = Rotor
 S = Stator

Accuracy: ' = arc minutes, " = arc seconds
Higher accuracy units available, please call factory.

Impedances:
Zpo = Impedance of the primary with the secondary open
Zso = Impedance of the secondary with the primary open

Other: —— = please consult factory

Notes:
1. Primary windings of both speeds are in parallel.
2. Rotation limited to ±30° due to connector.
3. These dimensions refer to the resolver with mounting rings and hubs. We can alter or delete the mounting rings and hubs as needed to meet your requirements. Tooling charges may apply.
4. These dimensions refer to resolver without mounting rings and hubs. We can add mounting rings and hubs as required to meet your requirements. Tooling charges may apply.

INTEGRATED MECHANISMS

Moog's unique product offering of motion technology (slip rings, motors, resolvers, drives and actuators) and fiber optic and multiplexing products provides the capital assets and engineering capabilities to design, manufacture and integrate these discrete products into an integrated gimbaled mechanism. In today's business environment where many corporate strategies are to focus on core competencies, let Moog take the design and integration of these discrete components into fully functional and tested subassemblies that are ready for installation into the end-item assembly. Should your strategy be to outsource these assemblies on a build-to-print or build-to-spec basis, we are ready to apply our resources so you can achieve those goals too.

Our integrated assemblies range from simple combinations of motors and resolvers to sophisticated electro-mechanical assemblies including the slip ring, brake, drive electronics, fiber optic rotary joints, hydraulic and pneumatic swivels and RF rotary joints. We also offer and provide fully integrated servo and utility actuators complete with precision gearing, clutches, brakes and closed-loop control electronics.

Our business strategy is simple, let Moog focus on what we do best so our customer can focus on what they do best. This strategy provides our customers with many measurable benefits.

Optimized systems that operate at peak performance

Tolerance stack up can rob magnetic and electromechanical designs of their intended performance capabilities. Maintaining air gap and mechanical tolerances are critical in precision electromechanical mechanisms. Even though the discrete components fall within specified tolerances, tolerance stack up may result in system performance problems. The end result is costly system redesign, component matching or assembly shimming for each item produced.

When a single manufacturer of these magnetic and electromechanical components has this responsibility, these issues are mitigated by careful attention to processing of the discrete components, thus ensuring a final assembly, that is electrically and mechanically aligned and fully tested.

System design can often be verified when a single manufacturer is able to conduct trade studies of the various components. Within a given mechanical envelop, space can be minimized, total component count reduced and structures sculpted with an end result of increased MTBF and reduced end-item weight.

Resource Optimization

This approach ensures system engineers are focused on the system, not its components. By focusing engineering resources, program risks are minimized, schedules maintained and costs reduced. Additionally, overhead costs are reduced by eliminating the manpower of soliciting multiple contractors and resulting contract administration, multiple incoming inspections of discreet components and the resulting expenses of pulling and distributing component kits. Additional program costs are saved by eliminating the need of holding multiple design reviews at different locations, multiple qualification tests and the review and approval of their related documents.

Accountability

You are assured that all system components are integrated properly and a fully tested end-item assembly is delivered. And, in the rare case that a technical problem should occur, you know exactly who to call for immediate help.

EXAMPLE OF INTEGRATED MOTION TECHNOLOGY
Primary Flight Control Surface Drive Assembly
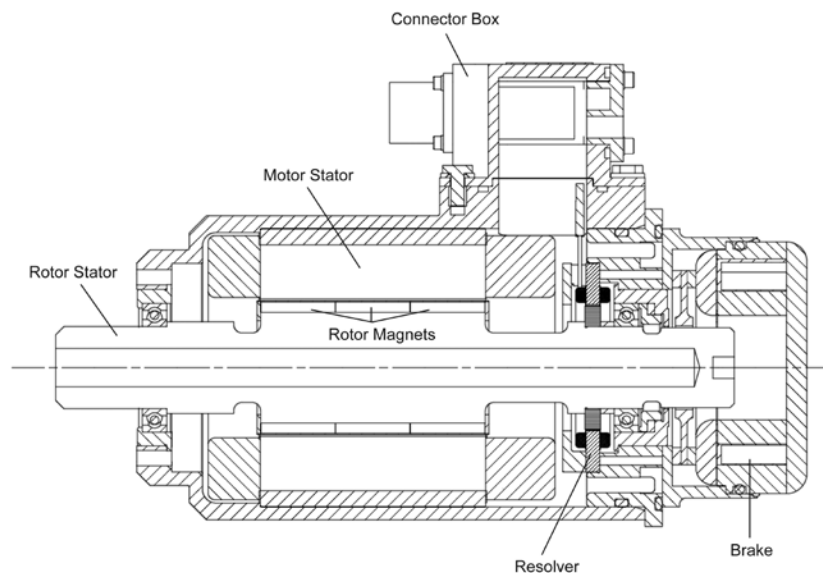
INTEGRATED MECHANISMS

With all marine, military and aerospace programs, a heritage of program success is essential. Moog has successfully provided integrated mechanisms to many mission critical programs including the following:

MARINE MARKET

Platform	Integrated Assembly	Status
Floating Production Storage and Offloading Vessel (FPSO)	Slip ring, FORJ, HUS and OEO converter Cables and junction boxes	Production
Remotely Operated Vehicles	Multiplexer, slip ring and FORJ	Production
Seismic Streamer	Slip ring and FRU Slip ring and FORJ	Production Production
Single Point Mooring System CALM Buoys	Slip ring, FORJ and FRU	Production

MILITARY MARKET

| Platform	Integrated Assembly	Status
Helicopter	Slip ring, resolver and RF rotary joint	Production
Helicopter	Twist cap and resolver	EMD
Rotorcraft	Slip ring, resolver and monopole sensor	Production
Armored Vehicle	Slip ring, resolver, R-to-D network, hydraulic and pneumatic swivel, and power distribution	Production
Armored Vehicle	Slip ring, encoder and pneumatic swivel	Production
Radar	Slip ring, motor, resolver, motor control and drive electronics, and 2-channel FORJ	EMD
Radar	Slip ring, digital resolver, motor and bull-gear	EMD
Radar	Servo actuator, motor and drive electronics	Production
Radar	Slip ring, FORJ and FRU	Production
Naval Towed Arrays	Slip ring, FORJ and FRU	Production

SPACE MARKET

Platform	Integrated Assembly	Status
Solar Array Drive	Slip ring, motor, harmonic drive and potentiometer	Flight
Solar Array Drive	Slip ring, motor and resolver	To-be-flown
Satellite Mechanism	Motor, ball screw and balanced weight	Flight

INDUSTRIAL MARKET

Platform	Integrated Assembly	Status
Rotary Piston Machining Centre	Mux, slip ring, FORJ and FRU	Prototype
Coal Stacker, Reclaimer	Slip ring, FORJ, FRU and encoder	Production

EXAMPLE OF INTEGRATED MOTION TECHNOLOGY

Fiber Optic Multiplexing System
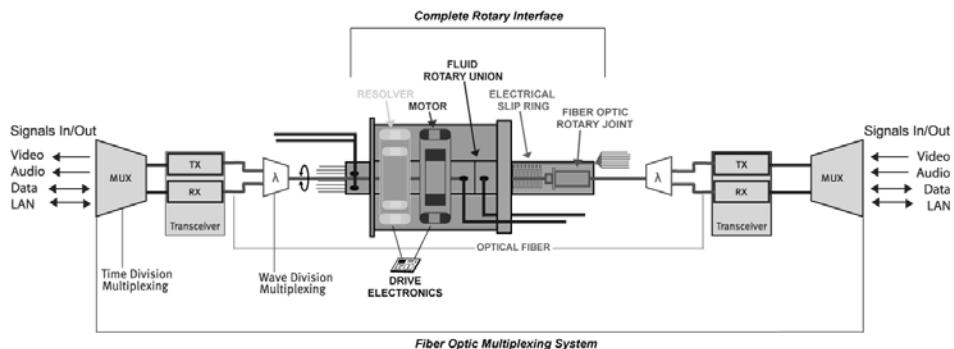
Moog looks forward to applying our design and manufacturing resources to your program's integrated assembly needs.

DEFENSE PRODUCTS

ROTARY JOINTS AND SLIP RINGS

These high performance products are used in systems that require unrestrained, continuous rotation while transmitting power, data and media from a stationary device to a rotating structure. High bandwidth options include Ethernet, high definition video and other industry standard formats. Moog also has solutions including fiber optic rotary joints, fluid rotary unions and position sensors.

DIRECT DRIVE DC TORQUE MOTORS AND ALTERNATORS

Frameless torque motors are used in defense applications that require high power density and quick accelerations. The motors are optimized to minimize input power for maximum efficiency. Alternators in the same mechanical configuration can be used for mobile power generation.

RESOLVERS

Moog offers rugged resolvers that provide accurate positioning and velocity feedback, as well as commutation of brushless motors. These models withstand the shock and vibration levels often encountered in aerospace and military applications. They are used for vertical integration with motors and slip ring assemblies.

ACTUATORS

Multi-purpose electromechanical actuators are available in both rotary and linear configurations and are standard building blocks in a variety of systems. Some of our actuators integrate servo electronics. These actuators are used on air, ground and unmanned applications.

HIGH SPEED DATA COMMUNICATIONS

Moog provides innovative components and communication sub-systems for both copper and optical fiber based systems used in harsh environments. Moog meets the demanding high speed and secure networking equipment requirements of todays modern defense systems. The product range includes electro-optical transceivers, link extenders, Ethernet media converters and switches, data aggregators and multiplexer/de-multiplexer solutions.

INTEGRATED MOTION ASSEMBLIES

Our higher level solutions range from simple combinations of individual products to sophisticated electromechanical assemblies including the motor, drive electronics, slip ring, fiber optic rotary joint, fluid / pneumatic swivel and RF rotary joint. Moog's single-axis gimbal stage supports most payloads, and all the rotary components are integrated into one assembly. This design reduces set-up time and simplifies the installation process.

NOTES

NOTES

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SPACE AND DEFENSE GROUP

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