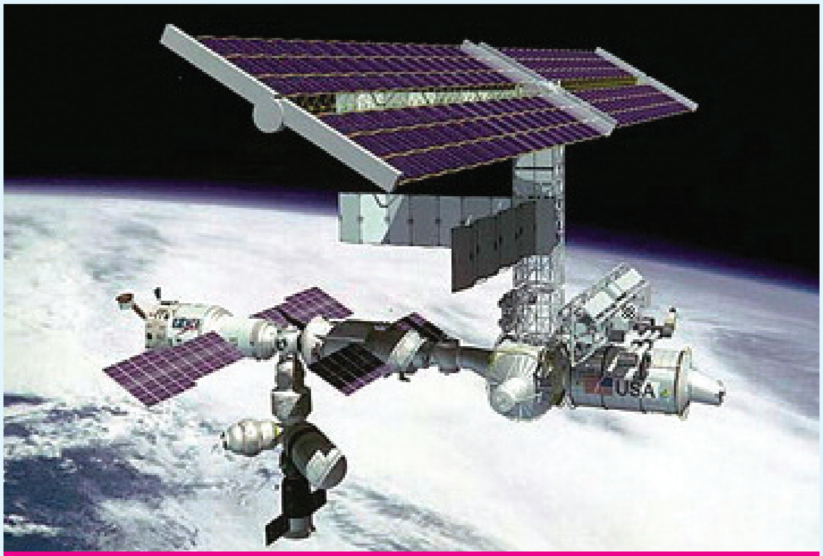
STEPPER MOTOR
ENGINEERING REFERENCE DATA



CDA InterCorp

CDA InterCorp

INTRODUCTION

This application manual defines the performance capabilities of CDA InterCorp's stepper motor product line with optional position, velocity, or acceleration feedback, detent or friction brakes, in-line or right angle geartrains, and linear conversion modules.

The design data contained herein reflects the continuous demand for improved performance, efficiency, and reliability while simplifying drive techniques, and minimizing size and weight. CDA products are designed to operate under the most demanding requirements of MIL-STD-810, while maintaining remote and automatic control of speed, torque, and/or position. These Controllable Drive Actuators are used in aerospace, outer space, defense, commercial aviation, "down hole" , and industrial control applications.

With over 30 years in the industry, CDA's core philosophy of modular standardization has withstood the test of time. Each module design utilizes the same inventoried piece part standards, materials, and construction techniques. Inherent in our standard modules is unequaled reliability and ruggedness, while maintaining flexibility in providing "custom" requirements and extremely responsive prototype deliveries.

CDA maintains a quality control system which assures tracibility and product assurance and performance. A government quality representative is available to provide source inspection, as required.

For responsive support to your specific requirements, please write, phone, or fax CDA directly. CDA's System Application Engineers are available to visit your facility to assist in the selection and integration of our rugged, high reliability products in your system. CDA provides marketing personnel throughout the United States and internationally.

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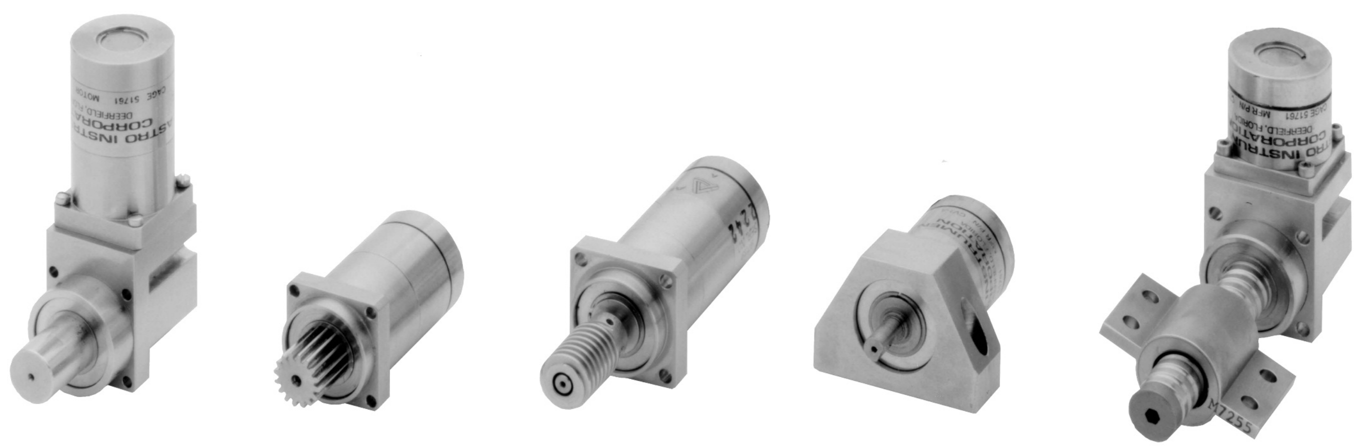


STEPPER MOTORS

CDA's stepper motors provide an incremental step output depending on the excitation logic applied to the motor windings. These stepper motors provide high running torque capacity per unit weight and size. Their high performance and excellent stepping accuracy make these components ideal in open loop positioning systems, incremental rate control systems, or limited angle rotary switches. Samarium cobalt rare earth magnets, high grade stainless steel construction, and class H225 insulation system assure rugged, reliable performance under the most severe operating conditions.

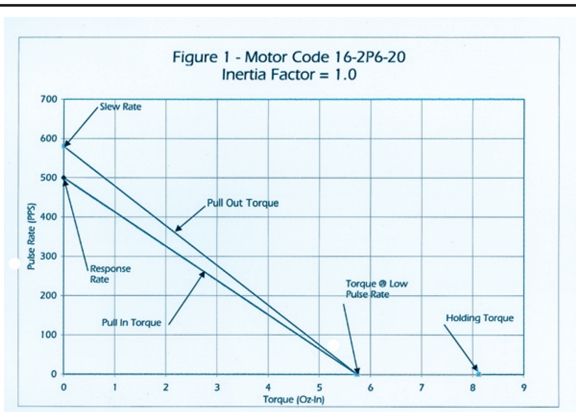
Applications for stepper motors include timing devices, field of view mechanisms, rotary solenoids, electro-optics, filters, antenna drives, robotics, and pointing mechanisms. CDA's high performance, high reliability stepper motors are ideal for these and other applications where size, weight, and reliability are critical. Advantages of stepper motors include simple electronics, high torque efficiency, precision step angles, and repeatable position increments.

CDA has the ability to provide these components with integrally mounted gearheads, brakes, position sensors, and rate sensors. All options are integrally mounted with no intermediate couplings, and have been qualified to the most demanding requirements of MIL-STD-810.

The performance characteristics tabulated in this catalog indicate the capabilities of CDA's stepper motors at various power inputs. It is important to note that "Motor Code" does not represent an off the shelf product, it merely delineates the motor's performance at a specific power level. CDA will custom wind a motor that is tailored for your application, even if the required performance falls between the tabulated performance data.

A stepper motor's performance is affected by load inertia. The design engineer must consider load inertia in dynamic step applications. If an application has a significant load inertia, the pulse rate may be "slewed", or increased dynamically, to obtain greater performance. The tabulated "No Load Response Rate" and "Max Power Output" characteristics are tabulated for inertially small reflected loads (Inertia Factor ≈1.0).

Figure 1 shows a typical pulse rate vs. torque curve. This performance is at +25° C, with a total inertia factor of 1.00 (load inertia ≈ 0). Also noted in this figure are some common terms



used throughout the catalog. The Pull In Torque is the load torque which the stepper motor can pull in from rest or reverse direction, at a specific pulse rate. The pull out torque is the torque which will pull the motor out of dynamic operation. The pull out torque falls along the "Slew" line, and is independent of load inertia.

Figure 2 shows the same stepper motor at +25° C, but with a total inertia factor of 2.0. Notice how the Slew Rate, Pull Out, Low Pulse Rate, and Holding performance have not changed, but the Response Rate and Pull In Torques have been reduced. To calculate the total inertia factor, see page 21 for stepper motor equations.

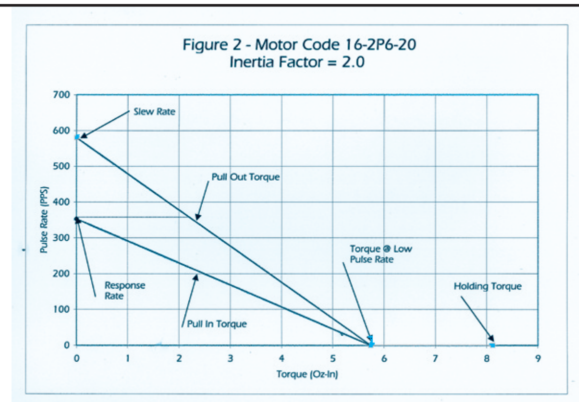
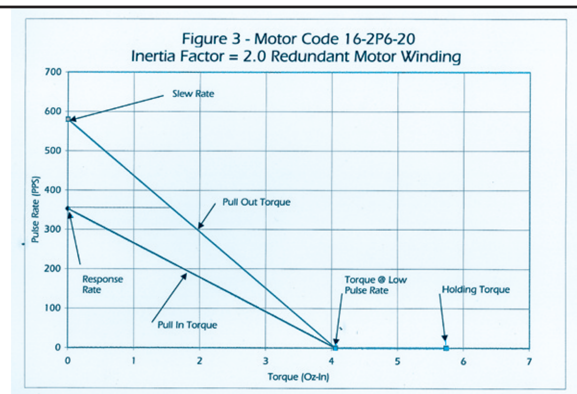
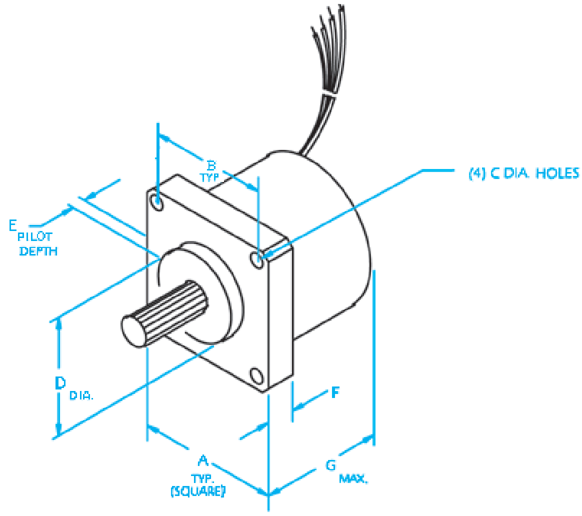


Figure 3 shows the same frame size motor in a system with an inertia factor of 2.0, and with redundant motor windings. Notice that the Slew and Response rates are the same as in figure 2, however, the motor holding torque and torque at low pulse rate have been reduced by a factor of 0.707. For analysis purposes, if you multiply the motor Km by 0.707, the analysis is linear. This same factor of 0.707 may be applied to unipolar driven motors. Unipolar - Redundant motors would have a 50% reduction in torque and Km from the values tabulated in this catalog.



It is recommended to fill out the Application Information Data Sheet on page 25, and fax this information directly to CDA, for verification of actuator performance in your system.

Motor Mechanical Data



IMPERIAL UNITS (DIMENSIONS IN INCHES)										
MOTOR TYPE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**WEIGHT (Oz.)**	**INERTIA ($Oz\text{-}In\text{-}s^2$)**	**Coulomb Friction (Oz-In)**
12	0.750	0.620	0.081	0.5000	0.040	0.125	0.780	1.2	9.50 E-06	0.15
16	1.000	0.828	0.110	0.6250	0.125	0.187	0.995	2.8	3.70 E-05	0.35
20	1.250	1.030	0.129	0.7500	0.125	0.250	1.280	5.0	1.00 E-04	0.60
24	1.500	1.250	0.149	0.8750	0.125	0.250	1.550	8.5	2.40 E-04	1.20
32	2.000	1.670	0.177	1.1250	0.125	0.375	1.911	19	1.00 E-03	2.00
40	2.500	2.080	0.266	1.5000	0.125	0.500	2.170	32	3.38 E-03	3.00
48	3.000	2.500	0.266	1.7500	0.125	0.500	2.500	64	7.78 E-03	5.00

SYSTEM INTERNATIONAL (DIMENSIONS IN mm)										
MOTOR TYPE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**WEIGHT (kg)**	**INERTIA ($kg\text{-}m^2$)**	**Coulomb Friction (Nmm)**
12	19.05	15.75	2.06	12.700	1.02	3.18	19.81	0.037	6.71 E-08	1.06
16	25.40	21.03	2.79	15.875	3.18	4.75	25.27	0.078	2.61 E-07	2.47
20	31.75	26.16	3.28	19.050	3.18	6.35	32.51	0.142	7.06 E-07	4.23
24	38.10	31.75	3.78	22.225	3.18	6.35	39.37	0.241	1.69 E-06	8.47
32	50.80	42.42	4.50	28.575	3.18	9.53	48.54	0.540	7.06 E-06	14.1
40	63.50	52.83	6.76	38.100	3.18	12.70	55.00	0.91	2.39 E-05	21.2
48	76.20	63.50	6.76	44.450	3.18	12.70	63.50	1.80	5.49 E-05	35.3

Notes:
1. Pilot to pinion concentricity = 0.0007 inches [0.018 mm] TIR.
2. Flange to pinion perpendicularity = 0.0007 inches [0.018 mm] TIR.
3. Composite error of assembled pinion = 0.011 inches [0.028 mm] TIR.
4. Other mounting configurations are available on request.
5. Contact CDA's engineering department for type 40 and 48 performance data.

TYPE 12 - 2 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
12-2P2-06	90	1.06	7.18	6	.75	5.3	130	1950	.38	2.6	4	260	3900	2	345	5175
12-2P2-10	90	1.37	9.67	10	.97	6.8	140	2100	.48	3.4	8	280	4200	6	470	7050
12-2P2-20	90	1.94	13.7	20	1.37	9.7	175	2625	.68	4.8	16	350	5250	14	700	10500
12-2P2-30	90	2.37	16.7	30	1.68	11.9	210	3150	.84	5.9	24	420	6300	21	900	13500

TYPE 12 - 4 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
12-2P4-06	45	1.92	13.6	6	1.36	9.60	200	1500	.68	4.8	4	400	3000	3	455	3412
12-2P4-10	45	2.48	17.5	10	1.75	12.4	240	1800	.88	6.2	8	480	3600	6	600	4500
12-2P4-20	45	3.51	24.8	20	2.48	17.5	290	2175	1.24	8.8	16	580	4350	12	900	6750
12-2P4-30	45	4.31	30.4	30	3.05	21.5	330	2475	1.52	10.7	24	660	4950	19	1150	8625

TYPE 12 - 6 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
12-2P6-06	30	2.22	15.7	6	1.57	11.1	262	1310	.78	5.5	4	525	2625	3	600	3000
12-2P6-10	30	2.87	20.3	10	2.03	14.3	312	1560	1.02	7.2	8	625	3125	5	815	4075
12-2P6-20	30	4.06	28.7	20	2.87	20.3	380	1900	1.44	10.2	16	760	3800	12	1200	6000
12-2P6-30	30	4.97	35.1	30	3.51	24.8	450	2250	1.76	12.4	24	900	4500	18	1600	8000

TYPE 12 - 2 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
12-3P2-06	60	1.22	8.61	6	.86	6.07	115	1150	.43	3.04	4	330	3300	3	400	4000
12-3P2-10	60	1.58	11.2	10	1.12	7.91	190	1900	.56	3.95	8	380	3800	5	535	5350
12-3P2-20	60	2.24	15.8	20	1.58	11.2	232	2320	.79	5.58	16	465	4650	12	800	8000
12-3P2-30	60	2.74	19.3	30	1.94	13.7	270	2700	.97	6.85	24	540	5400	18	1025	10250

TYPE 12 - 4 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
12-3P4-06	30	2.08	14.7	6	1.47	10.4	263	1315	.74	5.22	4	526	2630	3	600	3000
12-3P4-10	30	2.69	19.0	10	1.90	13.4	313	1565	.95	6.71	8	626	3130	5	816	4080
12-3P4-20	30	3.80	26.8	20	2.69	19.0	380	1900	1.34	9.46	16	760	3800	12	1200	6000
12-3P4-30	30	4.66	32.9	30	3.29	23.2	450	2250	1.64	11.6	24	900	4500	18	1600	8000

Notes:
1. Source voltages as required.
2. Other performance characteristics and power levels available on request.
3. Performance tabulated at +25° C unit temperature.
4. Note: the 6 pole two phase is the preferred standard.

TYPE 16 - 2 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
16-2P2-10	90	2.70	19.1	10	1.91	13.5	88	1320	.96	6.78	7	175	2625	4	192	2880
16-2P2-20	90	3.82	27.0	20	2.70	19.1	110	1650	1.35	9.53	14	220	3300	10	315	4725
16-2P2-40	90	5.39	38.1	40	3.81	26.9	138	2070	1.90	13.4	25	275	4125	24	480	7200
16-2P2-60	90	6.61	46.7	60	4.67	33.0	160	2400	2.34	16.5	40	320	4800	39	640	9600

TYPE 16 - 4 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
16-2P4-10	45	5.44	38.4	10	3.85	27.2	140	1050	1.92	13.6	7	280	2100	3	280	2100
16-2P4-20	45	7.66	54.1	20	5.42	38.3	185	1388	2.71	19.1	14	370	2775	8	415	3112
16-2P4-40	45	10.8	76.2	40	7.64	53.9	225	1688	3.82	27.0	25	450	3375	19	620	4650
16-2P4-60	45	13.3	93.9	60	9.40	66.4	245	1838	4.70	33.2	40	490	3675	31	775	5812

TYPE 16 - 6 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
16-2P6-10	30	5.74	40.5	10	4.06	28.7	188	940	2.03	14.3	7	375	1875	3	395	1975
16-2P6-20	30	8.12	57.3	20	5.74	40.5	250	1250	2.87	20.3	14	500	2500	6	580	2900
16-2P6-40	30	11.5	81.2	40	8.13	57.4	315	1575	4.06	28.7	25	630	3150	17	900	4500
16-2P6-60	30	14.0	98.8	60	9.90	69.9	362	1810	4.95	34.9	40	725	3625	27	1200	6000

TYPE 16 - 2 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
16-3P2-10	60	3.26	23.0	10	2.30	16.2	114	1140	1.15	8.12	7	228	2275	3	236	2360
16-3P2-20	60	4.61	32.5	20	3.26	23.0	148	1480	1.63	11.5	14	295	2950	6	365	3650
16-3P2-40	60	6.51	46.0	40	4.60	32.5	181	1810	2.30	16.2	25	362	3625	17	550	5500
16-3P2-60	60	7.98	56.3	60	5.64	39.8	202	2020	2.82	19.9	40	405	4050	27	708	7075

TYPE 16 - 4 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
16-3P4-10	30	5.53	39.0	10	3.91	27.6	188	940	1.96	13.8	7	376	1880	3	396	1980
16-3P4-20	30	7.83	55.3	20	5.54	39.1	250	1250	2.77	19.6	14	500	2500	6	580	2900
16-3P4-40	30	11.1	78.4	40	7.85	55.4	315	1575	3.92	27.7	25	630	3150	17	900	4500
16-3P4-60	30	13.6	96.0	60	9.62	67.9	363	1815	4.81	34.0	40	726	3630	27	1200	6000

Notes:

1. Source voltages as required.
2. Other performance characteristics and power levels available on request.
3. Performance tabulated at +25° C unit temperature.
4. Note: the 6 pole two phase is the preferred standard.

TYPE 20 - 2 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
20-2P2-12	90	5.72	40.4	12	4.04	28.5	82	1230	2.02	14.3	8	165	2475	3	160	2400
20-2P2-25	90	8.25	58.2	25	5.83	41.2	98	1470	2.92	20.6	16	195	2925	7	215	3225
20-2P2-50	90	11.7	82.6	50	8.27	58.4	115	1725	4.14	29.2	30	230	3450	20	320	4800
20-2P2-75	90	14.3	101	75	10.1	71.3	130	1950	5.05	35.7	50	260	3900	34	415	6225

TYPE 20 - 4 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
20-2P4-12	45	10.9	77.0	12	7.71	54.4	95	712	3.86	27.3	8	190	1425	5	190	1425
20-2P4-25	45	15.7	111	25	11.1	78.4	128	960	5.55	39.2	16	255	1912	8	255	1912
20-2P4-50	45	22.2	157	50	15.7	111	180	1350	7.85	55.4	30	360	2700	14	375	2812
20-2P4-75	45	27.2	192	75	19.2	136	220	1650	9.60	67.8	50	440	3300	21	485	3638

TYPE 20 - 6 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
20-2P6-12	30	12.1	85.4	12	8.55	60.4	110	550	4.28	30.2	8	220	1100	4	220	1100
20-2P6-25	30	17.5	124	25	12.4	87.5	165	825	6.20	43.8	16	330	1650	6	333	1665
20-2P6-50	30	24.7	174	50	17.5	124	242	1210	8.75	61.8	30	485	2425	10	510	2550
20-2P6-75	30	30.3	214	75	21.4	151	282	1410	10.7	75.5	50	565	2825	14	630	3150

TYPE 20 - 2 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
20-3P2-12	60	6.75	47.7	12	4.77	33.7	90	900	2.38	16.8	8	180	1800	4	180	1800
20-3P2-25	60	9.75	68.8	25	6.89	48.6	115	1150	3.44	24.3	16	230	2300	6	240	2400
20-3P2-50	60	13.8	97.4	50	9.76	68.9	150	1500	4.88	34.5	30	300	3000	10	350	3500
20-3P2-75	60	16.9	119	75	11.9	84.0	175	1750	5.95	42.0	50	350	3500	14	450	4500

TYPE 20 - 4 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
20-3P4-12	30	11.4	80.5	12	8.06	56.9	110	550	4.03	28.5	8	220	1100	4	220	1100
20-3P4-25	30	16.5	116	25	11.7	82.6	165	825	5.85	41.3	16	330	1650	6	330	1650
20-3P4-50	30	23.3	164	50	16.5	116	240	1200	8.25	58.2	30	480	2400	10	500	2500
20-3P4-75	30	28.6	202	75	20.2	143	282	1410	10.1	71.3	50	565	2825	14	640	3200

Notes:
1. Source voltages as required.
2. Other performance characteristics and power levels available on request.
3. Performance tabulated at +25° C unit temperature.
4. Note: the 6 pole two phase is the preferred standard.

TYPE 24 - 2 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
24-2P2-15	90	9.74	68.8	15	6.89	48.6	52	780	3.45	24.4	10	105	1575	3	110	1650
24-2P2-30	90	13.9	98.1	30	9.83	69.4	68	1020	4.92	34.7	20	135	2025	6	147	2205
24-2P2-60	90	19.5	138	60	13.8	97.4	88	1320	6.90	48.7	40	177	2655	15	222	3330
24-2P2-90	90	23.9	169	90	16.9	119	100	1500	8.45	59.7	60	200	3000	28	288	4320

TYPE 24 - 4 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
24-2P4-15	45	18.6	131	15	13.2	93.2	64	480	6.60	46.6	10	128	960	5	135	1012
24-2P4-30	45	26.2	185	30	18.5	131	89	668	9.25	65.3	20	178	1335	9	187	1402
24-2P4-60	45	37.0	261	60	26.2	185	134	1005	13.1	92.5	40	268	2010	18	270	2025
24-2P4-90	45	45.2	319	90	32.0	226	169	1268	16.0	113	60	338	2535	26	340	2550

TYPE 24 - 6 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
24-2P6-15	30	21.6	152	15	15.3	108	78	390	7.65	54.0	10	155	775	4	160	800
24-2P6-30	30	30.6	216	30	21.6	152	115	575	10.8	76.2	20	230	1150	8	235	1175
24-2P6-60	30	43.4	306	60	30.7	217	175	875	15.4	109	40	350	1750	19	355	1775
24-2P6-90	30	53.0	374	90	37.5	265	220	1100	18.8	133	60	440	2200	27	450	2250

TYPE 24 - 2 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
24-3P2-15	60	12.0	85.0	15	8.48	60	58	580	4.24	30.0	10	117	1170	4	125	1250
24-3P2-30	60	17.0	120	30	12.0	85	79	790	6.00	42.4	20	158	1575	7	170	1700
24-3P2-60	60	24.1	170	60	17.0	120	110	1100	8.50	60.0	40	221	2214	16	250	2500
24-3P2-90	60	30.0	208	90	21.2	150	132	1320	10.6	74.8	60	265	2646	27	340	3400

TYPE 24 - 4 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
24-3P4-15	30	20.5	145	15	14.5	102	78	390	7.25	51.2	10	156	780	4	160	800
24-3P4-30	30	29.0	205	30	20.5	145	115	575	10.2	72.4	20	230	1150	8	236	1180
24-3P4-60	30	41.1	290	60	29.1	205	175	875	14.6	103	40	350	1750	19	356	1780
24-3P4-90	30	50.3	355	90	35.6	251	220	1100	17.8	126	60	440	2200	27	450	2250

Notes:
1. Source voltages as required.
2. Other performance characteristics and power levels available on request.
3. Performance tabulated at +25° C unit temperature.
4. Note: the 6 pole two phase is the preferred standard.

TYPE 32 - 2 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
32-2P2-25	90	32.5	229	25	23.0	162	41	615	11.5	81.2	17	82	1225	9	90	1350
32-2P2-50	90	46.0	325	50	32.5	229	50	750	16.2	114	30	100	1500	15	110	1650
32-2P2-100	90	65.0	459	100	46.0	325	65	975	23.0	162	60	130	1950	30	150	2250
32-2P2-150	90	79.6	562	150	56.3	397	78	1170	28.2	199	100	155	2350	50	185	2775

TYPE 32 - 6 POLE - 2 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
32-2P6-25	30	57.8	408	25	40.9	289	51	255	20.4	144	17	102	510	8	104	520
32-2P6-50	30	81.6	576	50	57.7	407	76	380	28.8	203	30	152	760	15	153	765
32-2P6-100	30	116	819	100	82.0	579	113	565	41.0	289	60	226	1130	33	226	1130
32-2P6-150	30	142	1003	150	100	709	144	720	50.0	353	100	288	1440	52	292	1460

TYPE 32 - 2 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
32-3P2-25	60	32.5	229	25	23.0	162	44	440	11.5	81.2	17	88	875	8	90	900
32-3P2-50	60	46.0	325	50	32.5	229	56	560	16.2	115	30	113	1130	15	120	1200
32-3P2-100	60	65.0	459	100	46.0	325	77	770	23.0	162	60	154	1540	30	170	1700
32-3P2-150	60	79.6	562	150	56.3	397	95	950	28.2	199	100	190	1900	50	220	2200

TYPE 32 - 4 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
32-3P4-25	30	55.0	388	25	38.9	275	50	250	19.4	137	17	100	500	8	105	525
32-3P4-50	30	77.8	549	50	55.0	388	75	375	27.5	194	30	150	750	15	155	775
32-3P4-100	30	110	777	100	77.8	549	110	550	38.9	275	60	225	1125	30	230	1150
32-3P4-150	30	156	1101	150	110	777	140	700	55	388	100	285	1425	50	295	1475

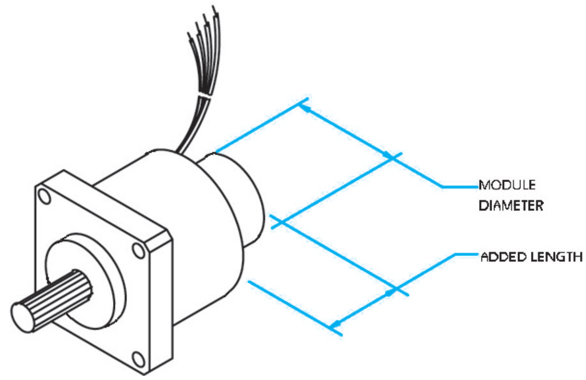
TYPE 32 - 6 POLE - 3 PHASE

MOTOR CODE	STEP ANGLE	HOLDING DATA			LOW PULSE RATE TORQUE		MAXIMUM POWER OUTPUT					NO LOAD				
		TORQUE		POWER INPUT			RATE		TORQUE		POWER INPUT	RESPONSE			SLEW	
												RATE		POWER	RATE	
	DEGREES	OZ-IN	Nmm	WATTS	OZ-IN	Nmm	PPS	RPM	OZ-IN	Nmm	WATTS	PPS	RPM	WATTS	PPS	RPM
32-3P6-25	20	62.5	441	25	44.2	312	62	205	22.1	156	17	123	410	7	125	415
32-3P6-50	20	88.4	624	50	62.5	441	95	315	31.2	221	30	190	635	13	195	650
32-36-100	20	125	882	100	88.4	624	150	500	44.2	312	60	300	990	28	310	1030
32-3P6-150	20	177	1250	150	125	882	195	650	62.5	441	100	390	1300	45	400	1330

Notes:

1. Source voltages as required.
2. Other performance characteristics and power levels available on request.
3. Performance tabulated at +25˚ C unit temperature.
4. Note: the 6 pole two phase is the preferred standard.

Standard Integral Components



CDA may incorporate complementary function modules on the back of our stepper motors to provide braking action or motor rotor feedback information. All of these modules are constructed with the same durable construction techniques and materials as our motors. CDA may also provide redundancy for the rotary transducers by cascading two or more modules in series.

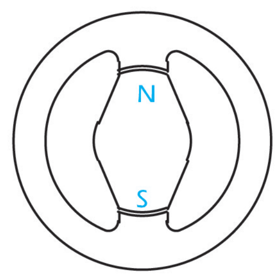
Refer to the following information and performance charts for some of our standard integral components. Other performance data or transducer output formats may be available on request.

DETENT BRAKES

Description / Application:
Magnetic Detent Brakes are integrally mounted with no intermediate couplings. The Detent Brake requires no excitation voltage or power input to provide additional holding torque at given step angles, while the motor is at rest. This device proves very useful when power off holding torque is required. The magnitude of the detent holding torque may be calibrated up to the maximum level tabulated below.

Typical applications include launch lock or over centering switches, where the coulomb friction of the motor is not enough to overcome system loads. Extremly popular in stepper motor applications, these devices typically correspond to the step angle of the motor, however, offsetting of the motor and brake step angles have been used to obtain custom torque versus position step profiles of the motor-brake combination.

In most applications where the motor step angle and the detent torque angle coincide, there is little to no net loss in motor running torque capacity. Since half of the magnetic detent cycle the brake is working against the motor torque, and the other half of the cycle the brake is working with the motor torque, there usually is no net loss in running torque capacity. As a general rule however, we typically recommend the detent holding torque be less than seventy percent of the motor torque at low pulse rate.



Schematic

	TYPE ——>	08D	11D
Holding Torque	Oz-In [Nmm]	3.0 [21]	15 [105]
Detent Torque Angle	Degrees	30, 45, 90, or 120	30, 45, 90, or 120
Added Length	Inches [mm]	0.400 [10.2]	0.400 [10.2]
Brake Diameter	Inches [mm]	0.750 [19.1]	1.062 [27.0]
Added Inertia	$Oz\text{-}In\text{-}sec^2$ [$kg\text{-}m^2$]	2.0 E-06 [1.4 E-08]	6.6 E-06 [4.7 E-08]
Added Weight	Oz [kg]	1.0 [0.028]	2.0 [0.057]

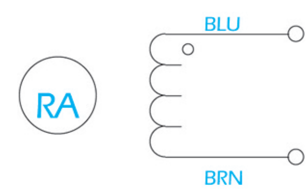
Notes:
1. Other torques and performance data available on request.
2. Detent Brakes may be sold as a stand alone item, or may be integrally mounted to a motor assembly, as shown above.

ROTARY ACCELEROMETERS

Description / Application:
Rotary Accelerometers (RA's) provide a DC output voltage in proportion to the phase and magnitude of the rotary acceleration of the motor shaft. These devices **require no excitation or input power**. RA's are ideal components to achieve high performance servo stability characteristics. The acceleration signal may be used alone, or the voltage may be op amp integrated to provide velocity damping plus acceleration information. Feedback can eliminate limited cycle oscillation in geared servo systems, and allow high forward loop gain through response shaping networks (PI OR PID), in digital or analog signal processing systems.

RA's may also be used in stepper motor applications, to determine the step "crossover" of the motor rotor during operation. This information is useful to determine optimum stepping pulse rate in high load inertia applications, or the stepper motor pulse rate may be dynamically controlled to step at the crossover point. This allows the motor to operate in the higher efficiency slew region of performance while maintaing step count. Since the permanent magnet Rotary Accelerometer provides a DC signal, the output may be directly used to determine step to step integrity of the stepper motor in critical pointing mechanisms, where step integrity is paramount.

The data included herein provides greater detail of the benefits and application information of RA's in stepper and servo motor applications.

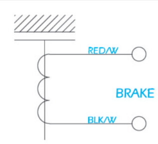
	TYPE ——>	03ACC	Schematic
Output Voltage	V/100kRAD/sec^2	0.60	
Output Load	Ohms	50,000	
Added Length (when integrated to motor)	Inches [mm]	0.622 [15.8]	
Accelerometer Diameter	Inches [mm]	0.750 [19.1]	
Added Inertia	Oz-In-sec^2 [kg-m^2]	6.6 E-05 [4.6 E-07]	
Added Weight	Oz [kg]	0.750 [0.021]	

Notes:
1. The information above is tabulated for an RA mounted directly to a CDA InterCorp motor assembly.
2. Tabulated performance at +25° C.

FRICTION BRAKES

Description / Application:
Friction Brakes are integrally mounted to the motor shaft with no intermediate couplings. These devices provide holding torque when the DC power is off, and allow the shaft to rotate freely when the DC voltage is applied to the brake winding.

An advantage of CDA InterCorp's friction brake design, is our ability to calibrate the braking torque within a specified range, up to the maximum rated torque for each frame size. Our friction brake materials are carefully selected to provide reliable performance over the life of the actuator.



Schematic

	TYPE ——>	08F	11F	15F	25F
Excitation Voltage	Volts DC	28	28	28	28
Current at 28 Volts DC	Amps DC	0.165	0.165	0.265	0.535
Pull In Voltage	Volts DC	18	18	18	18
Drop Out Voltage	Volts DC	1.0	1.0	1.0	1.0
Holding Torque	Oz-In [Nmm]	5.0 [35]	15 [105]	50 [350]	300 [2100]
Added Length	Inches [mm]	0.784 [19.9]	0.800 [20.3]	1.175 [28.8]	1.500 [38.1]
Brake Diameter	Inches [mm]	0.750 [19.1]	1.062 [27.0]	1.437 [36.5]	2.500 [63.5]
Added Inertia	Oz-In-sec^2 [kg-m^2]	2.0 E-06 [1.4 E-08]	6.6 E-06 [4.7 E-08]	2.4 E-05 [1.7 E-07]	2.2 E-04 [1.6 E-06]
Added Weight	Oz [kg]	1.0 [0.028]	2.0 [0.057]	6.0 [0.170]	24 [0.682]
Accelerometer-Brake Added Length	Inches [mm]	1.329 [33.8]	1.475 [37.5]	N/A	N/A
Accelerometer- Brake Added Inertia	Oz-In-sec^2 [kg-m^2]	5.0 E-06 [3.5 E-08]	6.1 E-05 [4.3 E-08]	N/A	N/A
Accelerometer-Brake Added Weight	Oz [kg]	2.3 [0.065]	4.5 [0.128]	N/A	N/A

Notes:
1. Other voltages, torques, and performance data available on request.
2. Brakes may be sold as a stand alone item, or may be integrally mounted to a motor assembly, as shown on page 9.
3. Listed performance at +25° C.

Motor Transducer Options

POSITION TRANSDUCER OPTIONS

Description / Applications: CDA may incorporate position feedback transducers for our stepper motors for closed loop operation, multiple speed transducer systems, rotary switch feedback, or high accuracy pointing mechanisms. The following tabulated transducer options may be integrated on the back of a stepper motor. For high accuracy load position feedback of geared stepper motors, see pages 16 & 17.

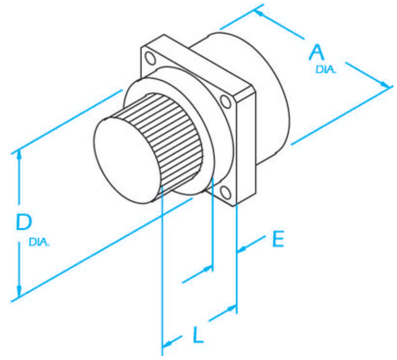
The rotary transducers tabulated here are typically used to provide position feedback of a direct drive stepper motor, or provide coarse feedback or unit step integrity on a geared "multiple speed" system. The "FD" type resolvers are also known as "Field Directors" and are also used for commutation purposes in Brushless Permanent Magnet Motors. However, when used on the back of a stepper motor, these devices provide reliable brushless position feedback of the motor's rotor shaft. This information is useful for motor step integrity or other applications where coarse positioning information is needed.

The 08BRX is a high accuracy size 08 Brushless Resolver. This high accuracy component may be used on the back of a permanent magnet stepper motor when used as a direct drive, limited angle drive, or rotary switch device. The advantage of this configuration is direct high accuracy position feedback in a streamline design. Additional information on the Brushless Resolvers may be found in our Rotary Transducer Application Data Catalog.

The 08RVDT is another higher accuracy position feedback option for limited angle or rotary switch applications. The limitations of the RVDT are the limited angle of operation (+/- 40˚), and the accuracy is not as high as a Brushless Resolver, and the value is expressed in terms of linearity, rather than angular accuracy. However, some customers prefer the electrical format of the RVDT. Additional information on the RVDTs may be found in our Rotary Transducer Application Data Catalog.

Type ——>		08FD2-2	08FD4-2	08FD6-2	08BRX	08RVDT	11FD2-2L	11FD2-2H	11FD4-2	11FD6-2
Format		Resolver	Resolver	Resolver	Resolver	RVDT	Resolver	Resolver	Resolver	Resolver
Cycles per Revolution		1x	2x	3x	1x	N/A	1x	1x	2x	3x
Excitation Voltage	Vrms	4.0	4.0	4.0	4.0	10.0	4.0	4.0	4.0	4.0
Frequency	Hz.	20,000	20,000	20,000	2,500	2,500	3,500	25,000	25,000	25,000
Accuracy	Degrees	5˚	3˚	2˚	0.05˚	0.5% Linearity	5˚	5˚	3˚	2˚
Untuned Current	Arms	.053	.060	.029	.010	.035	.077	.042	.041	.028
Tuned Current	Arms	.035	.028	.012	.004	.007	.045	.020	.013	.010
Output Voltage	Vrms	2.0	2.0	2.0	2.0	0.1/˚	2.0	2.0	2.0	2.0
Phase Shift	Degrees	-5˚	+5˚	+5˚	0º	0˚	+10˚	0˚	-5˚	-2˚
Output Load	kOhms	100	100	100	50	50	100	100	100	100
Added Length	Inches [mm]	.575 [14.6]	.575 [14.6]	.575 [14.6]	1.330 [33.8]	.870 [22.1]	.575 [14.6]	.575 [14.6]	.575 [14.6]	.575 [14.6]
Transducer Diameter	Inches [mm]	0.750	0.750	0.750	0.750	0.750	1.062	1.062	1.062	1.062
Added Inertia	Oz-In-sec^2 [kg-m^2]	1.3E-05 [9.1E-08]	1.3E-05 [9.1E-08]	1.3E-05 [9.1E-08]	1.5 E-05 [1.1E-07]	1.0 E-05 [6.5E-08]	1.3E-05 [9.1E-08]	1.3E-05 [9.1E-08]	1.3E-05 [9.1E-08]	1.3E-05 [9.1E-08]
Added Weight	Oz. [kg]	1.0	1.0	1.0	1.8	1.3	2.0	2.0	2.0	2.0

Gearhead Performance Data



FEATURES

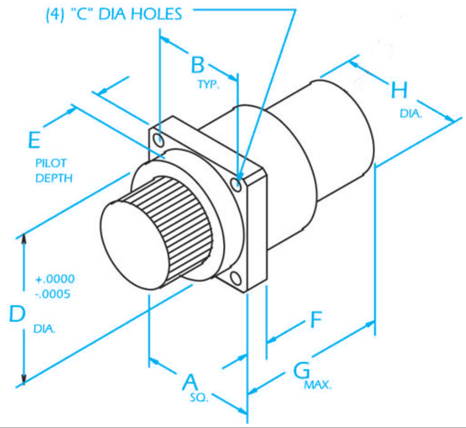
* High grade stainless steel construction *
* -80˚ C to +225˚ C wet lube operation *
* Application proven modular design *
* High torsional and radial stiffness *
* Low Backlash *

GEARHEAD RATINGS								
Gearhead Type	"A" Basic Size		Torque Capacity				Torsional Spring Constant	
			Continuous		Intermittent			
	Inches	mm	Lb-In	Nm	Lb-In	Nm	Lb-In/Rad	Nm/Rad
A	0.750	19.05	7.2	0.81	18	2.03	6.0 E+03	6.8 E+02
C	1.000	25.40	48	5.4	84	9.5	1.6 E+04	1.8 E+03
D	1.250	31.75	84	9.5	168	19	2.5 E+04	2.8 E+03
F	1.500	38.10	168	19	456	52	4.2 E+04	4.7 E+03
H	2.000	50.80	300	34	744	84	7.4 E+04	8.4 E+03
J	2.500	63.50	744	84	1500	170	1.8 E+05	2.0 E+04
M	3.000	76.20	1200	136	3000	340	6.0 E+05	6.8 E+04
N	4.000	101.60	3600	407	6900	780	3.6 E+06	4.1 E+05

STANDARD PINION DATA (In Inches) - See Note 6									
Gearhead Type	No. of Teeth	Diametral Pitch	Pressure Angle	Pitch Diameter	Testing Radius	Outside Dia. (Ref.)	"L"	"E"	"D"
A	22	64	20˚	0.3438	0.1719	0.375	0.500	0.156	0.6875
C	28	48	20˚	0.5833	0.2817	0.625	0.625	0.188	0.9375
D	26	32	20˚	0.8125	0.4063	0.875	0.750	0.250	1.1875
F	30	32	20˚	0.9375	0.4688	1.000	0.875	0.313	1.4375
H	29	24	20˚	1.2083	0.6042	1.292	1.000	0.375	1.8750
J	27	16	20˚	1.7500	0.8750	1.813	1.250	0.437	2.3750
M	35	16	20˚	2.1875	1.0938	2.313	1.500	0.500	2.9687
N	34	12	20˚	2.8333	1.4167	3.000	1.625	0.562	3.9687

Notes:
1. Pilot to pinion concentricity = 0.0007 inches [0.018 mm] TIR.
2. Flange to pinion perpendicularity = 0.0007 inches [0.018 mm] TIR.
3. Composite error of assembled pinion = 0.0011 inches [0.028 mm] TIR.
4. Involute tooth form AGMA quality 12.
5. All directions of rotation direct.
6. Other mounting, shaft, and pinion variations are available on request [Metric gears available].

Motor - Gearhead Composite Dimensions

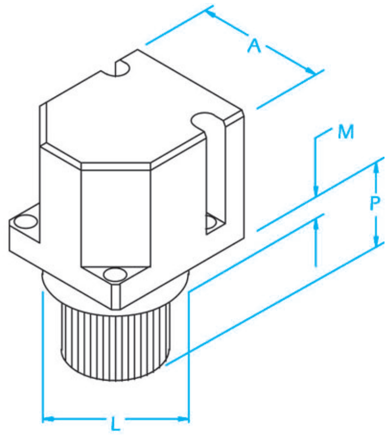


TYPE		RATIOS		Imperial Dimensions (In Inches)								WEIGHT	TEMP. COEF.
GEARHEAD	MOTOR	FROM	TO	A	B	C	D	E	F	G	H	Oz	(˚ C/Watt Loss)
AO	12	5	10	0.750	0.620	0.081	0.6875	0.156	0.188	1.184	0.750	2.1	7.0
AA	12	25	100	0.750	0.620	0.081	0.6875	0.156	0.188	1.744	0.750	3.0	7.0
CA	12	21	100	1.000	0.828	0.110	0.9375	0.188	0.250	1.821	0.750	4.2	6.9
AO	16	5	10	1.000	0.828	0.110	0.6875	0.156	0.250	1.400	1.000	4.0	4.5
CA	16	18	100	1.000	0.828	0.110	0.9375	0.188	0.250	2.036	1.000	6.5	6.2
DC	16	20	107	1.250	1.030	0.129	1.1875	0.250	0.250	2.126	1.000	8.5	6.1
CO	20	4	10	1.250	1.030	0.129	0.9375	0.188	0.250	1.757	1.250	7.5	3.0
DC	20	26	114	1.250	1.030	0.129	1.1875	0.250	0.250	2.407	1.250	12	4.5
FD	20	20	114	1.500	1.250	0.149	1.4375	0.313	0.313	2.527	1.250	15	4.5
CO	24	5	10	1.500	1.250	0.149	0.9375	0.188	0.313	2.082	1.500	13	2.3
DC	24	26	114	1.500	1.250	0.149	1.1875	0.250	0.313	2.696	1.500	17	2.5
FD	24	20	114	1.500	1.250	0.149	1.4375	0.313	0.313	2.816	1.500	18	4.5
HD	24	22	107	2.000	1.670	0.177	1.8750	0.375	0.375	3.011	1.500	27	4.5
D0	32	4	11	2.000	1.670	0.177	1.1875	0.250	0.375	2.310	2.000	26	1.7
FD	32	20	114	2.000	1.670	0.177	1.4375	0.313	0.375	3.162	2.000	31	1.7
HD	32	22	107	2.000	1.670	0.177	1.8750	0.375	0.375	3.357	2.000	40	2.5
JF	32	30	114	2.000	2.062	0.206	2.4375	0.437	0.500	3.613	2.000	66	2.4

TYPE		RATIOS		System International Dimensions (In mm)								WEIGHT	TEMP.COEF.
GEARHEAD	MOTOR	FROM	TO	A	B	C	D	E	F	G	H	kg	(˚ C/Watt Loss)
AO	12	5	10	19.05	15.75	2.06	17.463	3.96	4.78	30.08	19.05	0.060	7.0
AA	12	25	100	19.05	15.75	2.06	17.463	3.96	4.78	44.30	19.05	0.085	7.0
CA	12	21	100	25.40	21.03	2.80	23.813	4.78	6.35	46.26	19.05	0.119	6.9
AO	16	5	10	25.40	21.03	2.80	23.813	3.96	6.35	35.56	25.40	0.114	4.5
CA	16	18	100	25.40	21.03	2.80	23.813	4.78	6.35	51.72	25.40	0.185	6.2
DC	16	20	107	31.75	26.26	3.30	30.163	6.35	6.35	54.00	25.40	0.241	6.1
CO	20	4	10	31.75	26.16	3.30	23.813	4.78	6.35	44.63	31.75	0.213	3.0
DC	20	26	114	31.75	26.16	3.30	30.163	6.35	6.35	61.14	31.75	0.341	4.5
FD	20	20	114	38.10	31.75	3.80	36.513	7.95	7.95	64.19	31.75	0.426	4.5
CO	24	5	10	38.10	31.75	3.80	23.813	4.78	7.95	52.88	38.10	0.369	2.3
DC	24	26	114	38.10	31.75	3.80	30.163	6.35	7.95	68.78	38.10	0.423	2.5
FD	24	20	114	38.10	31.75	3.80	36.513	7.95	7.95	71.53	38.10	0.511	4.5
HD	24	22	107	50.80	42.42	4.50	49.213	9.53	9.53	76.48	38.10	0.767	4.5
D0	32	4	11	50.80	42.42	4.50	30.163	6.35	9.53	58.68	50.80	0.739	1.7
FD	32	20	114	50.80	42.42	4.50	36.513	7.95	9.53	80.32	50.80	0.881	1.7
HD	32	22	107	50.80	42.42	4.50	49.213	9.53	9.53	85.23	50.80	1.140	2.5
JF	32	30	114	63.50	52.37	5.23	61.913	11.10	12.70	91.77	50.80	1.880	2.4

1. Rate gearhead performance by the first letter of "Gearhead Type" tabulated. See preceding page.
2. Other gear ratios and mounting configurations are available on request.
3. Overall gearing efficiency = 90%
4. Temperature coefficient is in ˚C rise per watt loss, while mounted on a 6" x 6" x 0.25" black aluminum plate.
5. Unit wet lube operating temperature range = -80˚ C to +225˚ C.
6. Dry film lubrication operation down to 4 Kelvin. Call CDA's engineering department for further information.

Right Angle Gearhead Performance



FEATURES

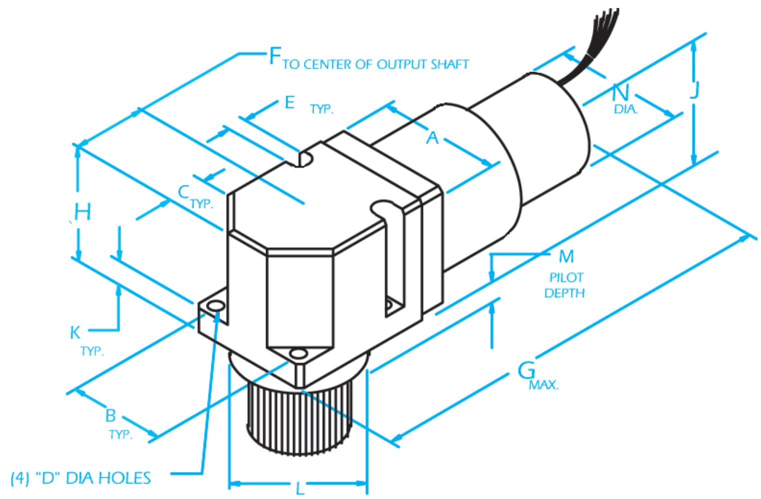
* High grade stainless steel construction *
* -80˚ C to +225˚ C wet lube operation *
* Application proven modular design *
* High torsional and radial stiffness *
* Low Backlash *

RIGHT ANGLE GEARHEAD RATINGS								
Gearhead Type	"A" Basic Size		Torque Capacity				Torsional Spring Constant	
			Continuous		Intermittent			
	Inches	mm	Lb-In	Nm	Lb-In	Nm	Lb-In/Rad	Nm/Rad
AR_	0.750	19.05	7.2	0.81	18	2.03	6.0 E+03	6.8 E+02
CR_	1.000	25.40	48	5.4	84	9.5	1.6 E+04	1.8 E+03
DR_	1.275	32.39	84	9.5	168	19	2.5 E+04	2.8 E+03
FR_	1.525	38.73	168	19	456	52	4.2 E+04	4.7 E+03
HR_	2.000	50.80	300	34	744	84	7.4 E+04	8.4 E+03
JR_	2.500	63.50	744	84	1500	170	1.8 E+05	2.0 E+04
MR_	3.500	88.90	1200	136	3000	340	6.0 E+05	6.8 E+04

STANDARD PINION DATA (In Inches) - See Note 6									
Gearhead Type	No. of Teeth	Diametral Pitch	Pressure Angle	Pitch Diameter	Testing Radius	Outside Dia. (Ref.)	"L"	"E"	"D"
A	22	64	20˚	0.3438	0.1719	0.375	0.500	0.156	0.6875
C	28	48	20˚	0.5833	0.2817	0.625	0.625	0.188	0.9375
D	26	32	20˚	0.8125	0.4063	0.875	0.750	0.250	1.1875
F	30	32	20˚	0.9375	0.4688	1.000	0.875	0.313	1.4375
H	29	24	20˚	1.2083	0.6042	1.292	1.000	0.375	1.8750
J	27	16	20˚	1.7500	0.8750	1.813	1.250	0.437	2.3750
M	35	16	20˚	2.1875	1.0938	2.313	1.500	0.500	2.9687
N	34	12	20˚	2.8333	1.4167	3.000	1.625	0.562	3.9687

Notes:
1. Pilot to pinion concentricity = 0.0007 inches [0.018 mm] TIR.
2. Flange to pinion perpendicularity = 0.0007 inches [0.018 mm] TIR.
3. Composite error of assembled pinion = 0.0011 inches [0.028 mm] TIR.
4. Involute tooth form AGMA quality 12.
5. All directions of rotation direct.
6. Other mounting, shaft, and pinion variations are available on request [Metric gears available].

Right Angle Gearhead Composite Dimensions



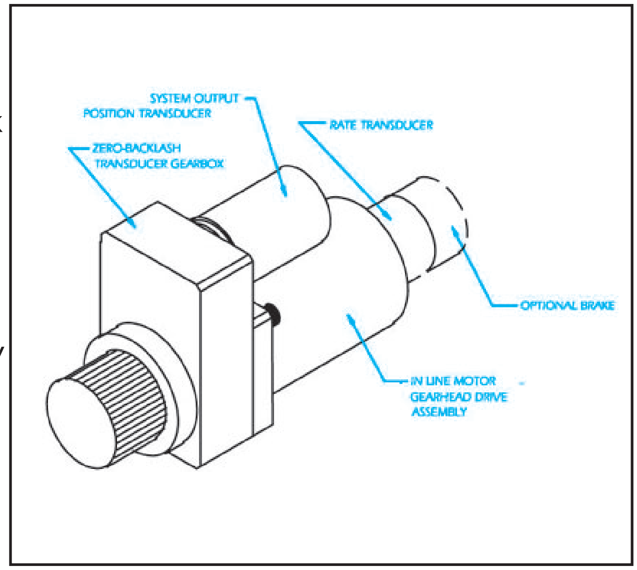
IMPERIAL UNITS - DIMENSIONS IN INCHES																	
TYPE		RATIOS (SEE NOTE 2)		A	B	C	D	E	F	G	H	J	K	L	M	N	WEIGHT	TEMP. COEF.
GEARHEAD	MOTOR	FROM	TO														OZ.	˚ C/WATT LOSS
ARA	12	46	187	0.750	0.620	0.229	0.081	0.140	0.375	2.130	0.833	0.436	0.188	0.7350	0.250	0.750	4.3	7.1
CRA	12	46	187	1.000	0.828	0.300	0.110	0.194	0.500	2.464	1.170	0.594	0.250	0.9750	0.313	0.750	8.0	7.0
CRA	16	46	187	1.000	0.828	0.300	0.110	0.194	0.500	2.680	1.170	0.594	0.250	0.9750	0.313	1.000	10	6.2
DRC	16	46	198	1.275	1.030	0.400	0.129	0.219	0.637	2.843	1.287	0.622	0.250	1.2500	0.313	1.000	16	6.1
DRC	20	16	198	1.275	1.030	0.400	0.129	0.219	0.637	3.232	1.287	0.622	0.250	1.2500	0.313	1.250	17	5.2
FRD	20	42	212	1.525	1.250	0.440	0.149	0.272	0.763	3.566	1.540	0.790	0.375	1.5000	0.375	1.250	25	5.0
HRD	20	45	200	2.000	1.670	0.585	0.177	0.316	1.000	4.003	2.062	1.062	0.375	1.9750	0.475	1.250	40	4.7
FRD	24	42	212	1.525	1.250	0.440	0.149	0.272	0.763	3.855	1.540	0.790	0.375	1.5000	0.375	1.500	28	3.0
HRD	24	45	200	2.000	1.670	0.585	0.177	0.316	1.000	4.292	2.062	1.062	0.375	1.9750	0.475	1.500	43	2.9
HRD	32	45	200	2.000	1.670	0.585	0.177	0.316	1.000	4.572	2.062	1.062	0.375	1.9750	0.475	2.000	52	2.1
JRF	32	30	129	2.500	2.060	0.750	0.206	0.430	1.250	5.340	2.562	1.312	0.500	2.4750	0.562	2.000	85	2.0

SYSTEM INTERNATIONAL - (DIMENSIONS IN mm)																		
TYPE		RATIOS (SEE NOTE 2)		A	B	C	D	E	F	G	H	J	K	L	M	N	WEIGHT	TEMP. COEF.
GEARHEAD	MOTOR	FROM	TO														kg	˚ C/WATT LOSS
ARA	12	46	187	19.05	15.75	5.82	2.06	3.56	9.35	54.10	21.16	11.07	4.78	18.669	6.35	19.05	.122	7.1
CRA	12	46	187	25.4	21.03	7.62	2.79	4.93	12.70	62.59	29.72	15.09	6.35	24.765	7.95	19.05	.227	7.0
CRA	16	46	187	25.4	21.03	7.62	2.79	4.93	12.70	68.07	29.72	15.09	6.35	24.765	7.95	25.40	.284	6.2
DRC	16	46	198	32.39	26.16	10.16	3.28	5.56	16.18	72.21	32.69	16.81	6.35	31.750	7.95	25.40	.455	6.1
DRC	20	46	198	32.39	26.16	10.16	3.28	5.56	16.18	82.09	32.69	16.81	6.35	31.750	7.95	31.75	.483	5.2
FRD	20	42	212	38.73	31.75	11.18	3.78	6.91	19.38	90.58	39.12	20.07	9.53	38.100	9.53	31.75	.710	5.0
HRD	20	45	200	50.80	42.42	14.86	4.50	8.03	25.40	101.7	52.37	26.97	9.53	50.165	12.07	31.75	1.14	4.7
FRD	24	42	212	38.73	31.75	11.18	3.78	6.91	19.38	97.92	39.12	20.07	9.53	38.100	9.53	38.10	.795	3.0
HRD	24	45	200	50.80	42.42	14.86	4.50	8.03	25.40	109.0	52.37	26.97	9.53	50.165	12.07	38.10	1.22	2.9
HRD	32	45	200	50.80	42.42	14.86	4.50	8.03	25.40	116.1	52.37	26.97	9.53	50.165	12.07	50.80	1.48	2.1
JRF	32	30	129	63.50	52.32	19.05	5.23	10.92	31.75	135.7	65.07	33.32	12.70	62.865	14.27	50.80	2.41	2.0

Notes:
1. Rate gearhead performance by the "Gearhead Type" tabulated. See preceding page.
2. Other gear ratios and mounting configurations are available on request.
3. Overall gearing efficiency = 85%
4. Temperature coefficient is in ˚C rise per watt loss, while mounted on a 6" x 6" x 0.25" black aluminum plate.
5. Unit wet lube operating temperature range = -80˚ C to +225˚ C.
6. Dry film lubrication operation down to 4 Kelvin. Call CDA's engineering department for further information.
7. "J" Dimension is from mounting surface to the centerline of the motor body diameter.

Rotary Actuators with High Accuracy Position Feedback

CDA InterCorp offers a line of high reliability position feedback gearboxes which adapt directly to our in line or right angle rotary actuators. These rugged devices incorporate output or load position feedback within a single package solution. The high accuracy position feedback transducer gearboxes also offer wide operating temperature range, and compact size.



CDA has the ability to incorporate high speed rotary transducers, such as resolvers or accelerometers, which are integrally mounted to the motor. This information, coupled with the load position feedback, may provide enhanced motor performance, or "multiple speed" position information.

The flexibility of CDA's standard modular design concept allows the incorporation of multifunction controllable drive actuators, with application proven ruggedness and reliability. These actuator packages offer unlimited design features within standard inventoried piece parts and design concepts.

Features:

* Zero-backlash precision gearing to high accuracy position transducer.

* -80˚ C to +225˚ C operating temperature range (wet lube).

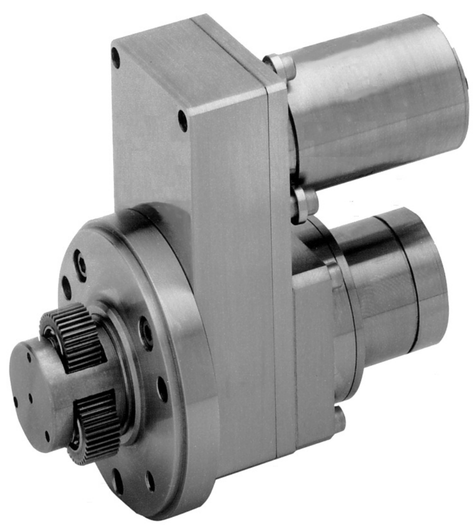
* System load position sensing and rate matching through zero-backlash gearing

* Three arc-minute brushless resolver availability.

* Multiple sensor capability.

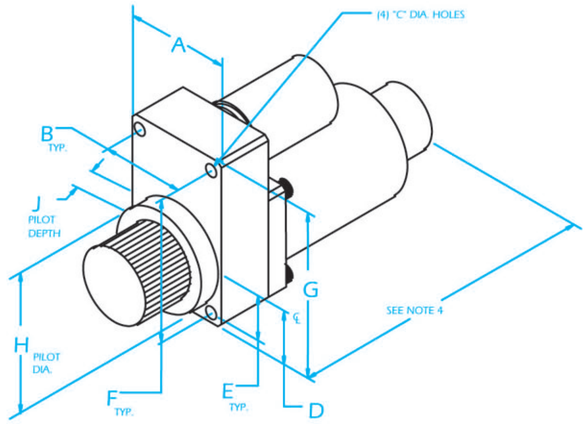
* Optional integral high speed rotary transducer.

* Optional integral brake.



* Refer to CDA InterCorp's Rotary Transducer Application Data catalog for sensor options and performance data.

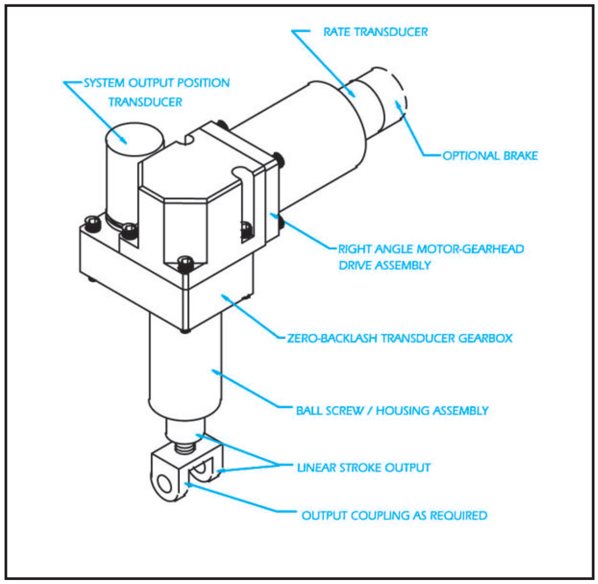
Rotary Actuators with High Accuracy Position Feedback



Imperial Units (In Inches)									
Gearbox Type	A	B	C	D	E	F	G	H	J
AT	0.750	0.620	0.081	0.375	0.310	1.937	2.110	0.6875	0.125
CT	1.000	0.828	0.113	0.500	0.414	1.953	2.125	0.9375	0.125
DT	1.250	1.030	0.140	0.625	0.515	1.864	2.062	1.1875	0.156
FT	1.500	1.250	0.150	0.750	0.625	2.125	2.375	1.4375	0.250
HT	2.000	1.670	0.175	1.000	0.835	2.686	3.016	1.8750	0.250
JT	2.500	2.062	0.210	1.250	1.031	3.062	3.500	2.4375	0.250

System International (In mm)									
Gearbox Type	A	B	C	D	E	F	G	H	J
AT	19.05	15.75	2.06	9.53	7.87	49.20	53.59	17.463	3.18
CT	25.40	21.03	2.87	12.70	10.52	49.61	53.98	23.813	3.18
DT	31.75	26.16	3.36	15.88	13.08	47.35	52.37	30.163	3.96
FT	38.10	31.75	3.81	19.05	15.86	53.98	60.33	36.513	6.35
HT	50.80	42.42	4.45	25.20	21.21	68.22	76.61	47.625	6.35
JT	63.50	52.37	5.27	31.75	26.19	77.77	88.90	61.913	6.35

Linear Actuator Assemblies



CDA InterCorp can provide linear actuation to our rotary actuators through the adaptation of ball screw or ACME lead screw outputs. In many applications, the linear screw may be ground integral to the output cage of the high torque rotary geartrain.

CDA may also incorporate a high accuracy rotary position transducer through a zero-backlash gearbox. This transducer may be geared such that the full stroke of the linear output translates to just under one full revolution of the transducer. This method is inherently more accurate, and provides higher reliability than using LVDT's or linear potentiometers. Additionally, high speed rate transducers and/or brakes may also be incorporated to provide full motion control capabilities in a single actuator package.

CDA has extended our modular design concepts for our rotary components to establish the same high standards for our linear actuators. These assemblies are extremely flexible in accommodating wide variations of linear stroke, force, and mounting configurations, within these standards. The utilization of rotary actuators with our standard linear design results in unparalleled reliability and performance. Most importantly, custom configurations and performance requirements can be accomplished with "off-the-shelf-technology". Fast prototype lead times and historical reliability and performance databases are also inherent in this design concept.

FEATURES:

* Optional position feedback through zero-backlash gearing.

* -80˚ C to +225˚ C operating temperature range (wet lube).

* High Accuracy Brushless Resolver, Synchro, or RVDT position transducer options.

* In-line or right angle power drive options.

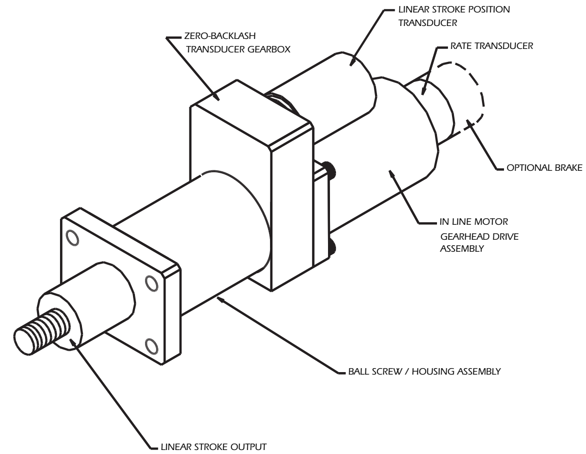
* Optional integral high speed transducer.

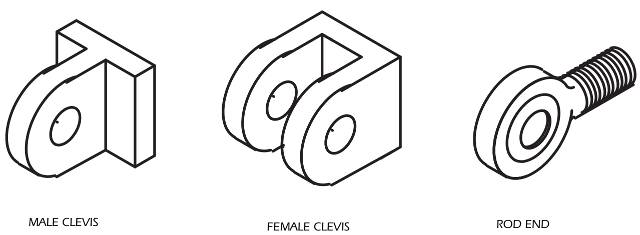
* Optional integral Friction or Detent Brake.

* High power output capacity.

* High thrust / pull force capacity.

CDA InterCorp may provide many mounting configurations for our linear actuators, while maintaing standard modules, materials, processes, and assembly techniques. The two basic mounting requirements are for the stationary mechanical ground, and the linear stroke output configuration. The mechanical ground may be flange mounted, as shown here to the right, or we may provide double ended clevis mounting, with some options shown below.

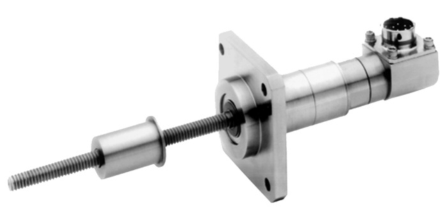




Shown to the left, are three options for the stroke output and / or mechanical ground mounting configurations. Male or female threads may also be provided for customer interface for either end of the actuator. The drawing above shows a male thread provided on the linear stroke output.

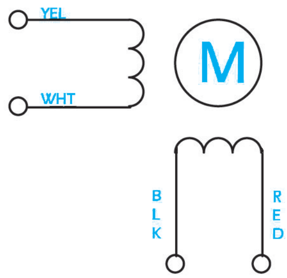
Other mechanical options include:

* Anti-rotation provision
* Ball screw with nut only
* ACME Lead Screw with nut only
* In-line, right angle, or "U" power drive configuration
* Hard mounted connector



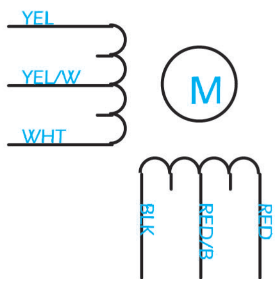
More options are shown in these photos. All of these custom end item configurations, start with our standard motors, gearboxes, and thrust adapters. These mechanical "embellishments" allow flexibility for integration and installation of our standard products, in a unique system application.

General Design Data
Phasing Diagrams



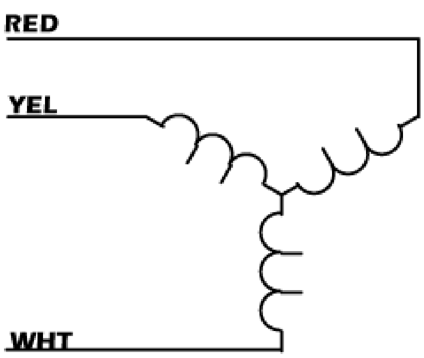
STEP	YEL	WHT	RED	BLK
1	+	-	+	-
2	+	-	-	+
3	-	+	-	+
4	-	+	+	-
5	+	-	+	-

Two Phase Bipolar - CCW Rotation Viewing Shaft



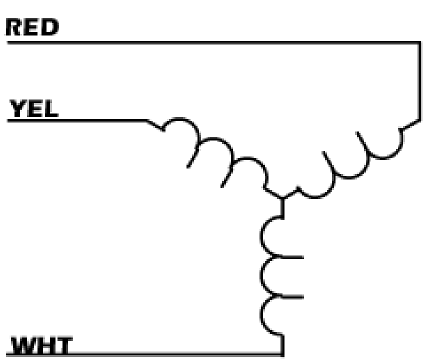
STEP	YEL	WHT	RED	BLK	Y/W	R/B
1	-	N/C	-	N/C	+	+
2	-	N/C	N/C	-	+	+
3	N/C	-	N/C	-	+	+
4	N/C	-	-	N/C	+	+
5	-	N/C	-	N/C	+	+

Two Phase Unipolar - CCW Rotation Viewing Shaft



STEP	YEL	RED	WHT
1	-	+	-
2	-	+	+
3	-	-	+
4	+	-	+
5	+	-	-
6	+	+	-

Three Phase - Two Leads Tied - CCW Rotation Viewing Shaft



STEP	YEL	RED	WHT
1	+	-	N/C
2	N/C	-	+
3	-	N/C	+
4	-	+	N/C
5	N/C	+	-
6	+	N/C	-

Three Phase - Line to Line - CCW Rotation Viewing Shaft

Stepper Motor Equations

STEPPER MOTOR EQUATIONS				
Symbol	Description	Units	Equation	
$\Delta\Theta_M$	STEP ANGLE AT MOTOR	DEGREES	$\Delta\Theta_M = 360 \div (\rho * Ø)$	
ω_m	VELOCITY AT MOTOR	RPM	$\omega_M = (\Delta\Theta_M * PPS) \div 6$	
N	GEAR RATIO	-	$N = \Delta\Theta_M \div \Delta\Theta_O$	
J_{LM}	LOAD INERTIA REFELECTED TO THE MOTOR	$Oz\text{-}In\text{-}sec^2$ or $kg\text{-}m^2$	$J_{LM} = J_L \div N^2$	
J_{ML}	MOTOR INERTIA REFLECTED TO THE LOAD	$Oz\text{-}In\text{-}sec^2$ or $kg\text{-}m^2$	$J_{ML} = J_M * N^2$	
J_F	INERTIA FACTOR	-	$J_F = (J_M + J_{LM}) \div J_M$	
K_m	MOTOR CONSTANT AT 25˚ C (REFERENCE)	Oz-In ÷ √watt or Nmm ÷ √watt	$K_m = T_H \div \sqrt{P_H}$	$K_m = K_T \div \sqrt{R}$
P_H	TOTAL POWER INPUT AT HOLDING, AT 25˚ C	Watts	$P_H = (T_H \div K_m)^2$	
R	DC RESISTANCE AT 25˚ C	Ohms	2ø: $R = (2 * V^2) \div P_H$	3ø: $R_{L\text{-}L} = V^2 \div P_H$
R_2	DC RESISTANCE AT OTHER TEMPERATURE (t_2)	Ohms	$R_2 = R\,(1+0.004(t_2-25))$	
I_H	DC CURRENT, AT HOLDING, AT 25˚ C	Amps	$I_H = V \div R$	
K_t	TORQUE CONSTANT	Oz-In/Amp or mNm/Amp	2ø: $K_t = T_H \div (1.414 * I_H)$	3ø: $K_t = T_H \div I_H$
T_H	HOLDING TORQUE, AT 25˚ C	Oz-In or mNm	2ø: $T_H = 1.414 * K_t * I_H$	3ø: $T_H = K_t * I_H$
$T_{PPS\Rightarrow 0}$	TORQUE AT LOW PULSE RATE, AT 25˚C	Oz-In or mNm	$T_{PPS\Rightarrow 0} = T_H * 0.707$	
RR_{JF}	INERTIA FACTORED RESPONSE RATE	PPS	$RR_{JF} = RR \div \sqrt{J_F}$	
T_{PPSm}	MOTOR PULL IN TORQUE AT APPLICATION PULSE RATE (PPS) , AT 25˚ C	Oz-In or mNm	$T_{PPSm} = (RR_{JF} - PPS) * T_{PPS\Rightarrow 0}) \div RR_{JF}$	
T_{PPSg}	GEARED ACTUATOR PULL IN TORQUE, AT APPLICATION PULSE RATE, AT 25˚ C	Oz-In or mNm	$T_{PPSg} = (T_{PPSm} * N * \eta_g)$	
K_B	BACK EMF CONSTANT (from Oz-In/Amp)	Vp/rad/sec	$K_B = K_T * 7.06\ E\text{-}03$	

Where:

ρ = Number of Poles
PPS = Pulses Per Second
V= Supply Voltage

RR =Response Rate
Ø = Number of Phases
$\Delta\Theta_o$ = Step Angle at Gearhead Output

J_L = Load Inertia
J_M = Motor Inertia
η_g = Gearhead efficiency

Rotary Accelerometer Applications

Rotary Accelerometers (RA's) have many practical uses for stepper motor applications. CDA InterCorp's RA's do not require excitation, and provide a DC output in proportion to the motor rotor acceleration. There is no need for external power input or output demodulation to process the signal. With excellent output gain, RA's provide high signal to noise ratio giving robust feedback signals. Typical benefits or applications with stepper motors include step crossover switching, unit step integrity feedback, inertial compensation, and dynamic speed vs. torque operation.

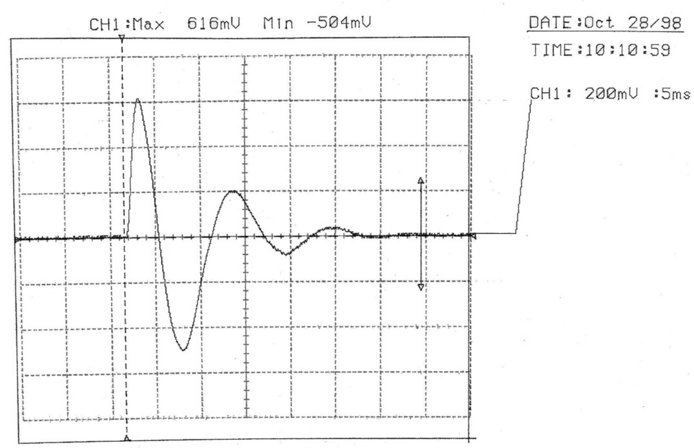
Crossover Switching is used to operate the stepper motor in the high speed slew region of performance. The output of the RA can be used to detect the crossover, or step angle, of the stepper motor. When the accelerometer output goes to zero, the unit step angle has been achieved, and the unit may be pulsed to the next step. Quite simply, set the "clock" input of the stepper motor to step when the accelerometer output goes to zero, this allows the motor to be stepped at the optimum pulse rate while maintaining pulse count, and eliminating overshoot oscillations.

This type of stepper motor control may offer many benefits to the performance of a stepper motor. This technique automatically slews the motor to the maximum allowable pulse rate for a given torque load, or it may also be "clocked" to limit the pulse rate to a specific limit. One disadvantage of conventionally driven stepper motors is the fact that if pull out torque capacity is reached in an application, the motor will lose all torque capacity and fall out of operation. However, with Crossover Switching, if the pull out torque capacity is reached at a specific pulse rate, the motor does not lose torque capacity, but rather simply reduces pulse rate automatically - significantly increasing torque margin capacity of a motor without increasing power input.

Unit Step Integrity Feedback may be obtained by looking at the magnitude of the output of the RA. For each given step output, the RA will produce an output signal in response to each pulse. This information is useful in determining whether or not the motor has stepped in response to the pulse. Additionally, this may be used in indexing, or initializing, a stepper motor against a stop in order to "zero" the motor step count. An RA can provide the information to determine if steps have been missed, or if an end stop has been reached.

Inertial Compensation may be derived by feeding the acceleration signal back to a power stage amplifier, to minimize the effect of overshoot and resonant situations. If current feedback is available in the stepper motor controller, the RA's output may be used as feedback into a current loop, which may eliminate high inertial load resonances and torque reduction areas. For a simpler approach, RA's may be used to determine optimum stepping rate for a specific application. By analyzing the accelerometer output, it can be easily determined where the ideal stepping rate is, within a given range, by assuring that the motor is stepping in the proper region of operation. With the characteristic overshoot and bounce inherent in stepper motors, there are some pulse rates which result in an increase in torque capacity, and some pulse rates which result in a reduction of torque capacity. It is easily determined from the output of an RA where these operational pulse rates occur. This information is very beneficial for minimization of power consumption, or system simulation purposes.

Below is an actual scope trace which shows the output of a type 03ACC RA, on the back of a type 16-2P6-20 stepper motor. This is a classic acceleration profile for a single step of a stepper motor. From this direct output you can determine crossover time, overshoot, settling time, desired optimum pulse rate for maximum dynamic torque, and unit step integrity. For performance critical applications , the RA output may be utilized to determine mechanism integrity through the acceleration output. There will be a direct indication from the RA if torque or friction levels of the load or mechanism increases. The brushless DC output provides the ultimate in simplicity, reliability, and effectiveness.



Dynamic Speed vs. Torque Operation may be obtained with a stepper motor with RA feedback. As mentioned under the Crossover Switching section, a stepper motor with RA feedback may obtain dynamic speed vs torque characteristics. Without the RA, stepper motors are usually driven at a fixed operational clock, or pulse rate. Once the pull out torque capacity of such a stepper motor is reached for a given pulse rate, the stepper motor will not continue to run, and the motor will loose all torque capacity. Conversely, with the RA feedback, once the pull out torque capacity has been reached, the motor simply slows down to a lower pulse rate, rather than pull out of operation. This increases torque margin and capacity tremendously, as the stepper motor now performs more like a servo motor, without the complicated electronics. The information on the following page shows the benefits of Dynamic Speed vs. Torque Operation for specific examples, and other performance enhancing characteristics of an RA.

Torque Margin and System Diagnostic information are easily provided by observing the direct output of the RA during operation, and comparing the voltage magnitude with the minimum voltage output to assure reliabe stepping. This provides direct proportional torque margin information.

Rotary Accelerometer Applications

The following performance data comparison and performance curves display the benefits which may be realized when a RA is incorporated on a stepper motor actuator. The following scenarios compare a CDA InterCorp Type 16-2P6-20 Stepper Motor, with a 100:1 Type CA gearbox, and a load inertia of 0.125 Oz-In-s2. This specific combination results in an "Inertia Factor" of 38. These results reflect actual test data.

Figure 1 show this motor driven with a conventional "open loop" stepper motor controller. Figure 2 is the identical actuator's dynamic speed vs. torque performance when using RA Crossover Switching.

In addition to the obvious performance enhancement of higher torques and operating velocities, the RA also provides several other tangible benefits. With the RA, pulse by pulse information is inherently provided. That is, there are no "lost steps". Additionally, resonance areas, or unstable performance, are inherently nullified, and dynamic speed versus torque is realized.

Figure 1 - Motor Code 16-2P6-20 with 100:1 Gearhead
Inertia Factor = 38 - **Conventionally Driven**

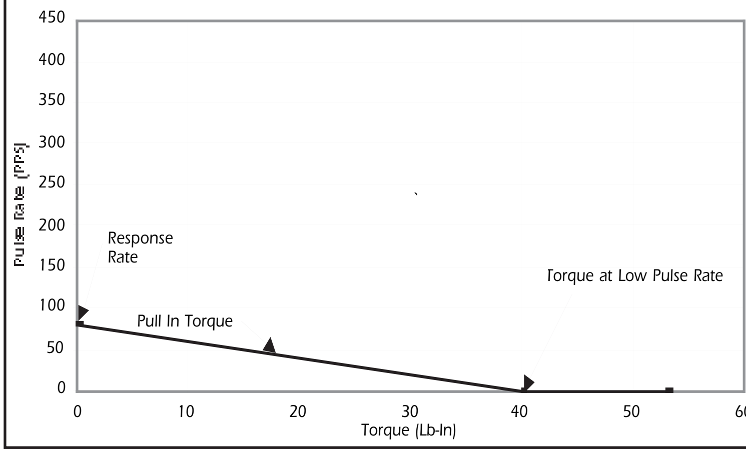
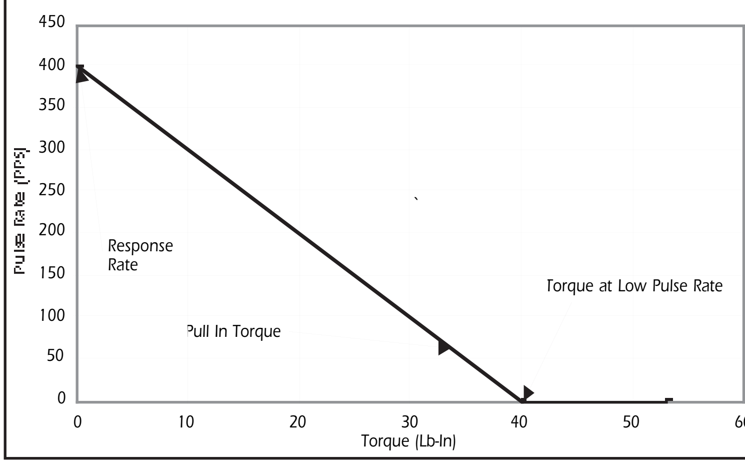


Figure 2 - Motor Code 16-2P6-20 with 100:1 Gearhead
Inertia Factor = 38 - **RA Crossover Switching**



Performance Data Comparison

Parameter			RA Drive Performance	Conventional Drive Performance
Response Rate	Pulses Per Second		**400**	80
Pull In Torque at 60 PPS	Lb-In [Nm]		**34 [3.8]**	10.5 [1.2]
Maximum Power Output Performance	Torque	Lb-In [Nm]	**25 [2.8]**	25 [2.8]
	Speed	Pulses Per Second	**200**	40
Continuous Stable Operation			**Yes**	No
Step Count Verification			**Yes**	No

GLOSSARY OF TERMS

Back emf: *Is the generated output voltage per RPM (or Rad/sec) of a permanent magnet motor.*

Bipolar: *Refers to a full reversal of current into each phase of a stepper motor. For maximum performance and effectiveness, bipolar operation is recommended. The performance data in this catalog is tabulated for bipolar operation.*

Coulomb Friction: *Is the zero speed magnetic drag friction plus detent torque of the stepper motor. This is the total torque required to rotate the motor rotor shaft.*

Detent Torque: *The peak magnetic holding torque of a detent brake OR the peak to peak variation in backdriving torque of the motor rotor. This is the total variation of the low speed friction of the motor.*

Holding Torque: *The peak torque of a permanent magnet stepper motor when the motor is excited with rated DC voltage. This value is calculated from the motor torque constant.*

Inertia Factor: *The effect on load inertia reflected to the stepper motor response rate and pull in torque.* *See page 2 for detailed description, and page 21 for equations.*

InterDamp: *Optional Electromagnetic damping added to a stepper motor or Rotary Switch to minimize the effect of load inertia or overshoot and settling time.*

Max Power Output: *Is the operational pulse rate point for maximum power output. These catalog values are for reference only, to give an indication of the dynamic operational performance.*

Motor Constant or K_M: *Is the holding torque per square root watt of power input, at +25˚ C. This figure of merit is a useful means to compare the performance of a permanent magnet stepper motor.*

Poles: *The number of electromagnetic faces per phase in the stator of a stepper motor.*

Power Input: *Is the TOTAL power input to a stepper motor. Please note that the power per phase of a two phase stepper motor will be one half the value tabulated in the performance charts in this catalog.*

Pull In Torque: *The magnitude of torque which a stepper motor can pull in from rest, or reverse direction, at a specific pulse rate. The Pull In Torque performance falls along a line between the Inertia Factored Response Rate and the Torque at Low Pulse Rate.*

Pull Out Torque: *The magnitude of torque which will pull the stepper motor out of dynamic operation. The Pull Out Torque performance falls along a line between the Slew Rate, and the Torque at Low Pulse Rate.*

Pulse: *The application or reversal of input voltage polarity into a stepper motor winding.*

Pulses per Second or PPS: *The number of individual pulses or steps applied to a stepper motor per second.*

Resonance: *Is a situation where high reflected load inertia causes significant overshoot, resulting in missed steps or loss of motor torque capacity.*

Response Rate: *Is the maximum rate which a stepper motor will obtain synchronous operation from rest, with no load inertia or friction applied.*

Rotary Switch: *Is a stepper motor used as a two position rotary position selector.*

Slew Operation: *Is the technique of dynamically increasing the pulse rate to operate the stepper motor in the pull out torque region of motor performance.*

Slew Rate: *Is the maximum no load pulse rate which a stepper motor can obtain while operating in the slew operation mode.*

Step: *The single response to a pulse.*

Step Angle: *The magnitude of rotary motion obtained by a single step.*

Torque Constant or K_T: *Is the proportional holding torque generated from the stepper motor per DC amp input.*

Torque at Low Pulse Rate: *Is the dynamic (greater than one pulse) torque capacity of a stepper motor, as the pulse rate approaches zero.*

Unipolar: *Refers to unidirectional flow of current into each leg of a motor winding. Unipolar operation will result in a reduction of motor performance.*

FAX COVER SHEET

To:	**Company:**	CDA InterCorp	**Phone No:**	954-698-6000
	Attention:	Application Engineering	**Fax No:**	954-698-6011
	Date:		**Reference:**	
FROM:	**Company:**		**Phone No.:**	
	Name:		**FAX No.:**	
	Mail Stop:		**e-mail:**	
Subject:	Request for Information			

Fill in known data and fax this sheet directly to CDA InterCorp for an immediate response. Be sure to include preferred units.

APPLICATION DATA SHEET

Parameter	Value	Units
Supply Voltage Range		Volts DC
Operating Temperature Range		
Redundant Motor Windings	[ ] Yes	[ ] No
Rotary Actuator Application		
Load Inertia		
Bull Gear Ratio		
Output Torque at Load		
Output Speed at Load		
Step Resolution per Pulse at Load		
Motor Velocity Feedback Required	[ ] Yes	[ ] No
Acceleration Feedback Required	[ ] Yes	[ ] No
Brake Requirement	[ ] Friction [ ] Detent	[ ] None
Brake Torque at Load		
Integral Load Position Feedback	[ ] Yes	[ ] No
Comments / Duty Cycle Description:		
Linear Actuator Application		
Load Mass		
Output Force		
Output Velocity		
Output Stroke		
Step Resolution per Pulse at Load		
Motor Velocity Feedback Required	[ ] Yes	[ ] No
Acceleration Feedback Required	[ ] Yes	[ ] No
Brake Requirement	[ ] Friction [ ] Detent	[ ] None
Brake Force		
Integral Load Position Feedback	[ ] Yes	[ ] No
Comments / Duty Cycle Description:		

CDA InterCorp Products

Motor Modules:

- Brushless Permanent Magnet Motors
- AC Induction Motors
- Stepper Motors
- Square Wave Driven AC Motors
- Damped Rotary Switches
- Housed Limited Angle Torquers
- Synchronous Motors

Eddy Current Dampers:

- Rotary
- Linear
- In Line or Right Angle
- Damping "enable" option

Gearing Modules:

Rotary:

- High Torque Planetary
- Right Angle Gearing
- High Accuracy Zero Backlash Gearing
- Precision Indexing Drive Gearing

Linear:

- Ball Screw Actuation
- ACME Lead Screw Actuation
- In-line, Right-angle, or U-drive

Brakes:

- DC Friction Brakes
- Permanent Magnet Detent Brakes
- DC Magnetic Induction Brakes

Transducers:

Position Transducers:

- Brushless Resolvers
- Single Speed
- Multiple Speed
- Tandem or Cluster Redundant
- With or without Gearing
- *OnAxis* Resolvers
- RVDT's
- Tandem or Cluster Redundancy
- With or without Gearing
- *OnAxis* RVDT

Velocity Transducers:

- AC Tachometers
- Damping Tachs
- Rate Tachs
- Permanent Magnet Alternators
- Single Speed
- Multiple Speed
- With or without Gearing

Acceleration Transducers:

- Brushless DC Rotary Accelerometers
- DC Excited Rotary Accelerometers

CDA InterCorp can combine these standard modules into multi-function integrated actuators and assemblies. Call CDA InterCorp directly for application engineering assistance, or to request a complete set of application data brochures.

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