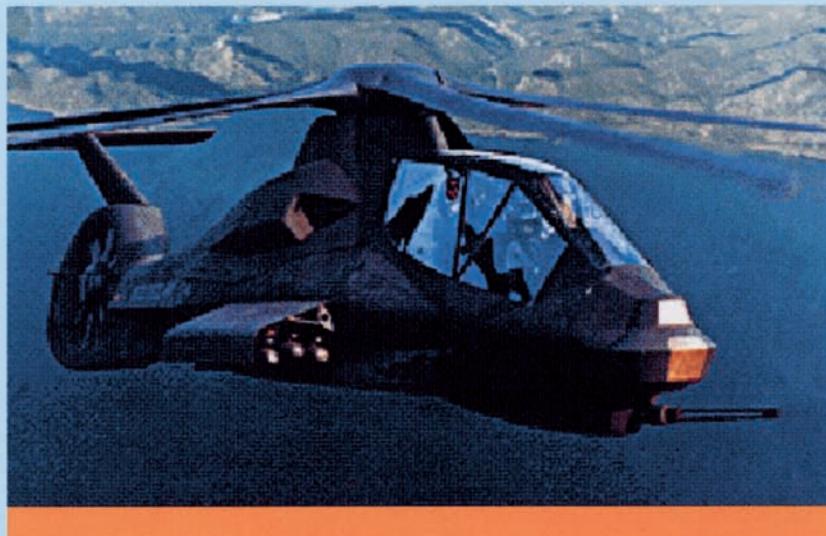


**AC INDUCTION MOTOR
ENGINEERING REFERENCE DATA**



ISO 9001 : 2000
Certified

CDA INTERCORP

C D A I N T E R C O R P

I N T R O D U C T I O N

This application manual defines the performance capabilities of **CDA INTERCORP'S** AC Induction Motor product line, in-line and right angle gearing, optional rotary transducers, brakes, 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 InterCorp's AC Motors are designed to operate under the most demanding requirements of MIL-STD-810, while maintaining robust, reliable performance characteristics. These motors and similar products are used in aerospace, outer space, defense, commercial aviation, "down hole", robotic, nuclear, and high reliability industrial control applications.

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

CDA InterCorp's Quality system is certified to ISO-9001: 2000. A government quality representative is available to provide source inspection, as required.

For responsive support of your specific requirements, please write, phone, fax, or e-mail CDA InterCorp directly. CDA's system application engineers are available to visit your facility to assist in the design and selection of the proper Controllable Drive Actuator for your specific application. CDA also maintains marketing personnel throughout the United States and Internationally.



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AC Induction Motors

CDA INTERCORP's AC Induction Motors provide high reliability and high efficiency, with unparalleled performance per unit volume and weight. The engineering reference data delineated nominal motor performance for our seven frame size motors, over a range of operational frequencies. With advances in motor winding configurations, control electronics, and drive techniques, high performance AC motors are no longer limited to 400 Hz operation. Induction motors are used in many applications where less reliable Brush Type DC motors or higher complexity Brushless Motors were previously used.

CDA's high efficiency induction motors produce high torque at speed, resulting in excellent speed regulation at high frequencies. This speed-torque characteristic often allows the use of an AC induction motor, rather than a hysteresis synchronous motor, for applications which require relative constant velocities with varying loads. Additionally, CDA's motors produce high torque per watt characteristics, when driven at low frequencies. This coupled with their high torque capacity per unit volume results in a compact low power, high torque generating actuator with cost effective drive circuitry.

CDA's Induction motors feature Class H225 insulation and lubrication system, with matched CTE materials. This assures high performance and capacity per unit volume and weight. The ruggedness and reliability designed into all of our modular designs assures long life and repeatable performance.

While we may discuss and introduce different drive techniques and source voltages, all of our motor frame sizes may be wound to be driven off any frequency from 50 to 800 Hertz, and may be wound for low, moderate, or high voltage systems, and optimized for sinusoidal or square wave voltage sources.

DRIVE OPTIONS:

FIXED & CONTROL PHASE OPERATION

One technique of closed loop motor control is the "Fixed Phase" method of applying power to one of the motor phases continuously, and varying the magnitude and polarity of the "Control" phase, based upon the magnitude of the error signal. This method, while somewhat outdated, provides an accurate, reliable method of servo control. The magnitude of the power input of the fixed phase may be lower than the power input of the control phase, in order to reduce steady state power losses, and lower the temperature rise of the motor. While the steady state power loss of the motor is lower than a balanced fixed phase operation, the total power input will be higher. The stall power inputs tabulated in this brochure is the total power input for balanced power operation. For example, motor type 20-6-400-06 tabulates a stall power of 90 watts. For balanced power, the motor would have 45 watts per phase of power input ($P_T = P_{FB} + P_{CB}$). For unbalanced power, the product of powers would be equal to the product of powers for a balanced motor for equivalent performance. That is: $P_{FB} * P_{CB} = P_{FU} * P_{CU}$. Therefore, if we wanted to set the fixed phase for the unbalanced winding to 15 watts ($P_{FU} = 15$), and solve for the control phase winding, P_{CU} , we get: $P_{CU} = (P_{FB} * P_{CB}) / P_{FU}$, which solves to 135 watts for the unbalanced control phase stall power. With 15 watts on the fixed phase, the motor steady state temperature rise would be lower compared to the balanced motor, but the total power input at

stall is 150 watts, as compared to 90 watts for a balanced option.

DUAL WINDING CONTROL

Dual Winding Control (DWC) is a more current method of closed loop operation with an AC induction motor. This method simultaneously applies the two phase voltages in proportion to the error signal input. Driving both phases is similar to Brushless Permanent Magnet Motor control techniques. Not requiring the motor fixed phase to have continuous power reduces the zero speed quiescent power loss and motor temperature rise. Additionally, the DWC allows balanced power, resulting in better torque per watt characteristics. See page 30 for additional information on DWC AC induction motors.

SQUARE WAVE DRIVEN MOTORS

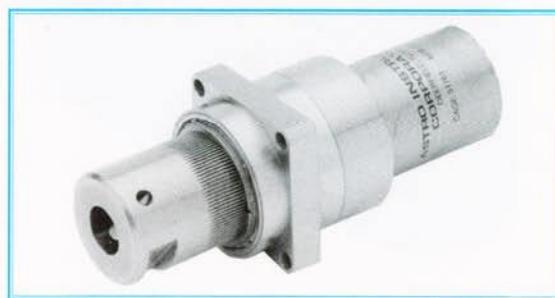
CDA can provide windings for AC motors which allow high efficiency operation from a square wave voltage source. This provides AC motor performance from SC source voltages. Stepper motor electronics which drive permanent magnet stepper motors may also be used for CDA line of AC motors designed to operate off these square wave voltages. However, AC induction motors are more efficient and have higher power output capacity when compared to stepper motors.

Some advantages of this drive technique are: Simple high efficiency drive circuitry; high efficiency operation; selection of operating frequency; wide range of Torque vs. Speed characteristics; DC source voltages; brushless design; excellent speed regulation; and variable frequency operation option.

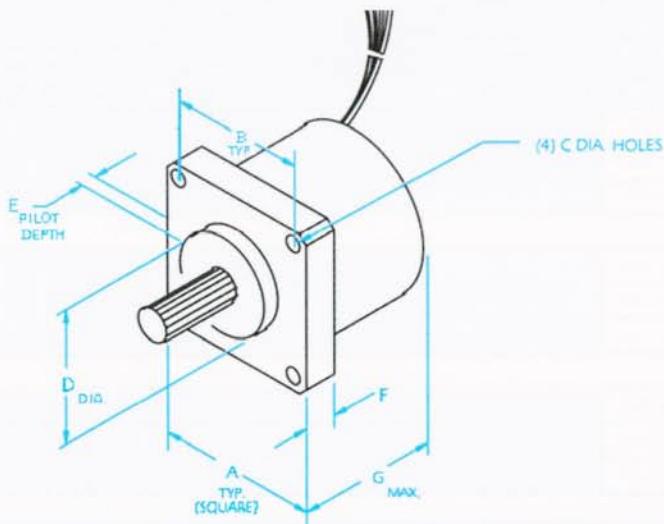
VARIABLE FREQUENCY SQUARE WAVE DRIVEN

The performance data summary tabulated for each motor modular frame size is formatted to allow performance comparison at various operational frequencies. While the selection of a single operating frequency may provide adequate performance, variable frequency drives can significantly increase performance and efficiency per unit volume. Controlling the frequency allows high torque per watt performance at low speeds, while providing high power output and efficiency at high operational speeds.

Square wave drive electronics makes the implementation of variable frequency AC motors an easy task. Simply set the clock frequency into the square wave drive electronics to vary with the motor velocity, which is determined through an AC tachometer. See page 31 for additional information on variable frequency square wave driven AC induction motors.



Motor Mechanical Data



IMPERIAL UNITS (DIMENSIONS IN INCHES)

MOTOR TYPE	A	B	C	D	E	F	G	WEIGHT (Oz.)	INERTIA (Oz-in-s ²)
12	0.750	0.620	0.081	0.5000	0.040	0.125	0.780	1.2	9.00 E-06
16	1.000	0.828	0.110	0.6250	0.125	0.187	0.995	2.8	3.40 E-05
20	1.250	1.030	0.129	0.7500	0.125	0.250	1.280	5.0	1.00 E-04
24	1.500	1.250	0.149	0.8750	0.125	0.250	1.550	8.5	2.50 E-04
32	2.000	1.670	0.177	1.1250	0.125	0.375	1.911	19	9.60 E-04
40	2.500	2.080	0.266	1.5000	0.125	0.500	2.170	32	1.50 E-03
48	3.000	2.500	0.266	1.7500	0.125	0.500	2.500	64	2.62 E-03

SYSTEM INTERNATIONAL (DIMENSIONS IN mm)

MOTOR TYPE	A	B	C	D	E	F	G	WEIGHT (kg)	INERTIA (kg-m ²)
12	19.05	15.75	2.06	12.700	1.02	3.18	19.81	0.037	6.36 E-08
16	25.40	21.03	2.79	15.875	3.18	4.75	25.27	0.078	2.4 E-07
20	31.75	26.16	3.28	19.050	3.18	6.35	32.51	0.142	7.06 E-07
24	38.10	31.75	3.78	22.225	3.18	6.35	39.37	0.241	1.77 E-06
32	50.80	42.42	4.50	28.575	3.18	9.53	48.54	0.540	6.71 E-06
40	63.50	52.83	6.76	38.100	3.18	12.70	55.00	0.91	1.01 E-05
48	76.20	63.50	6.76	44.450	3.18	12.70	63.50	1.80	1.85 E-05

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 motor thermal characteristics.
6. Contact CDA's engineering department for type 40 and 48 performance data

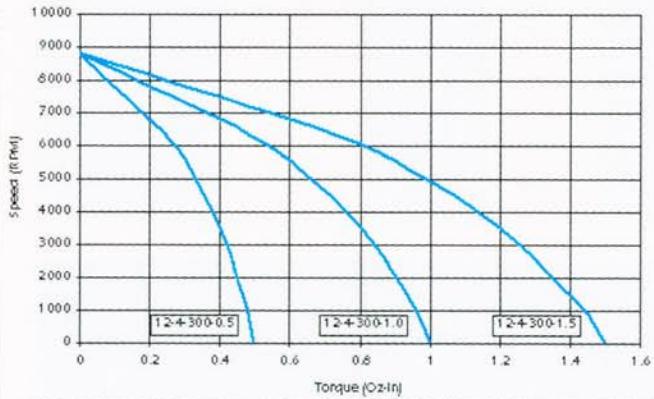
TYPE 12 , 4 POLE PERFORMANCE

Motor Code	Frequency	No Load Speed	Performance at Speed						Performance at Stall			
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Factor	
			Hz	RPM	Oz-In	mNm	RPM	Watts	Watts		Oz-In	
12-4-300-0.5	300	8800	0.3	2	5500	1.2	6	0.71	0.5	4	9	0.83
12-4-300-1.0	300	8900	0.6	4	5500	2.4	11	0.71	1.0	7	18	0.83
12-4-300-1.5	300	8900	0.9	6	5500	3.7	18	0.71	1.5	11	27	0.83
12-4-400-0.5	400	11600	0.3	2	8250	1.8	7	0.68	0.5	4	10	0.79
12-4-400-1.0	400	11600	0.6	4	8250	3.7	14	0.68	1.0	7	20	0.79
12-4-400-1.5	400	11700	0.9	6	8250	5.5	21	0.68	1.5	11	30	0.79
12-4-500-0.5	500	14500	0.3	2	10500	2.3	8	0.66	0.5	4	13	0.75
12-4-500-1.0	500	14500	0.6	4	10500	4.7	16	0.66	1.0	7	26	0.75
12-4-500-1.5	500	14600	0.9	6	10500	7.0	24	0.66	1.5	11	39	0.75
12-4-600-0.5	600	17500	0.3	2	13500	3.0	9	0.65	0.5	4	15	0.74
12-4-600-1.0	600	17500	0.6	4	13500	6.0	18	0.65	1.0	7	30	0.74

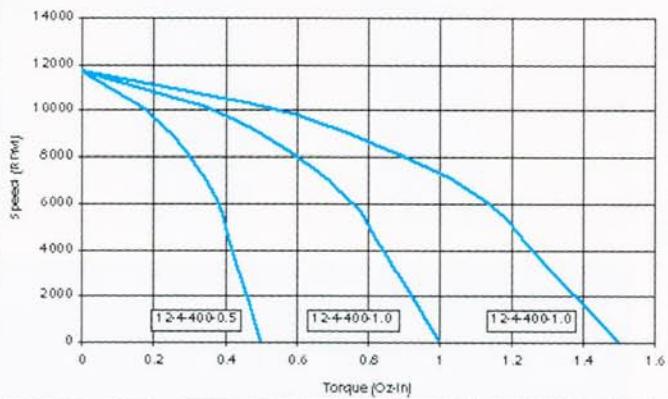
NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.

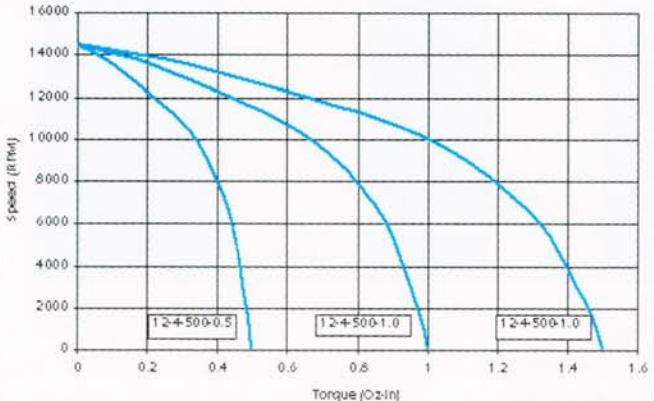
Type 12, 4 Pole, 300 Hz
Speed vs. Torque



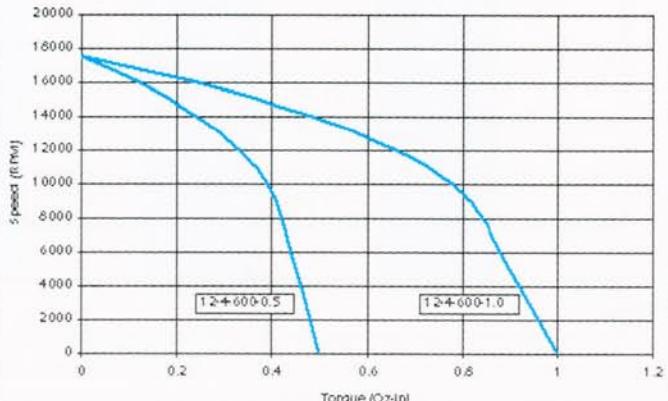
Type 12, 4 Pole, 400 Hz
Speed vs. Torque



Type 12, 4 Pole, 500 Hz
Speed vs. Torque



Type 12, 4 Pole, 600 Hz
Speed vs. Torque



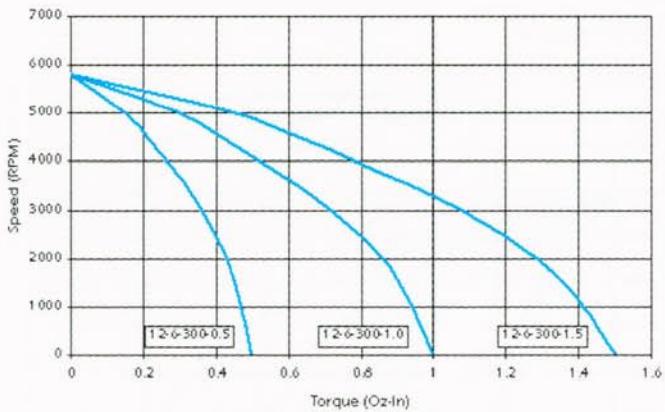
TYPE 12 , 6 POLE PERFORMANCE

Motor Code	Frequency	No Load Speed	Performance at Speed						Performance at Stall			
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Input	Power Factor
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts		Oz-In	mNm	Watts	
12-6-300-0.5	300	5800	0.3	2	3750	0.8	6	0.71	0.5	4	8	0.83
12-6-300-1.0	300	5800	0.6	4	3750	1.7	11	0.71	1.0	7	17	0.83
12-6-300-1.5	300	5800	0.9	6	3750	2.5	18	0.71	1.5	11	26	0.83
12-6-400-0.5	400	7650	0.3	2	5000	1.1	7	0.68	0.5	4	9	0.79
12-6-400-1.0	400	7700	0.6	4	5000	2.2	14	0.68	1.0	7	18	0.79
12-6-400-1.5	400	7750	0.9	6	5000	3.3	21	0.68	1.5	11	30	0.79
12-6-500-0.5	500	9700	0.3	2	7250	1.6	8	0.66	0.5	4	11	0.75
12-6-500-1.0	500	9750	0.6	4	7250	3.2	16	0.66	1.0	7	22	0.75
12-6-500-1.5	500	9800	0.9	6	7250	4.8	24	0.66	1.5	11	35	0.75
12-6-600-0.5	600	11750	0.3	2	8250	1.8	9	0.65	0.5	4	12	0.74
12-6-600-1.0	600	11750	0.6	4	8250	3.7	18	0.65	1.0	7	25	0.74

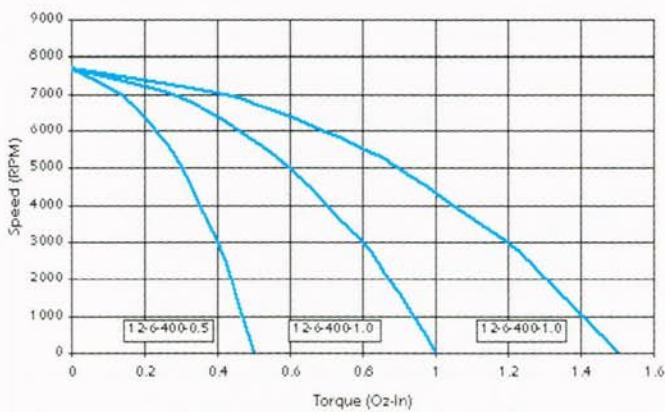
NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.

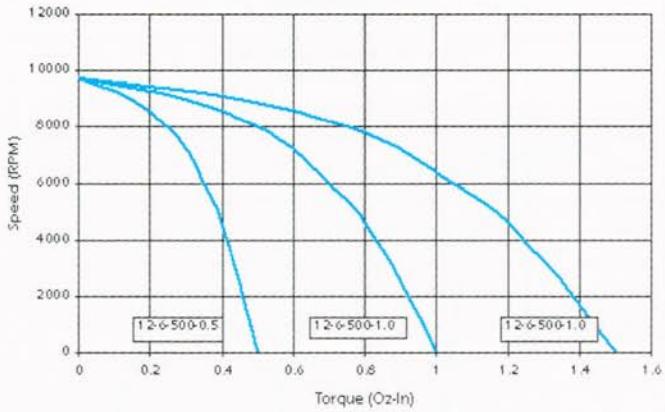
Type 12, 6 Pole, 300 Hz
Speed vs. Torque



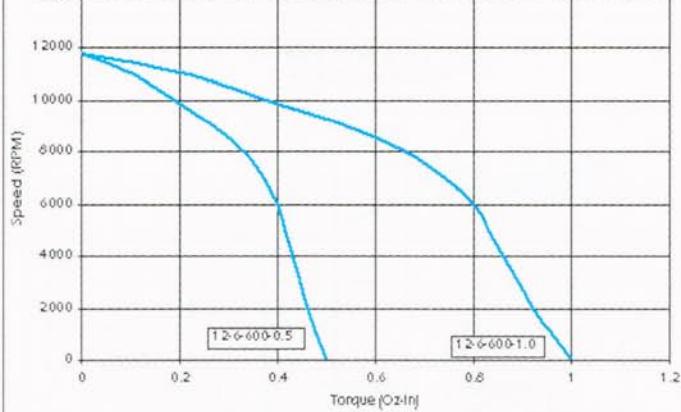
Type 12, 6 Pole, 400 Hz
Speed vs. Torque



Type 12, 6 Pole, 500 Hz
Speed vs. Torque



Type 12, 6 Pole, 600 Hz
Speed vs. Torque

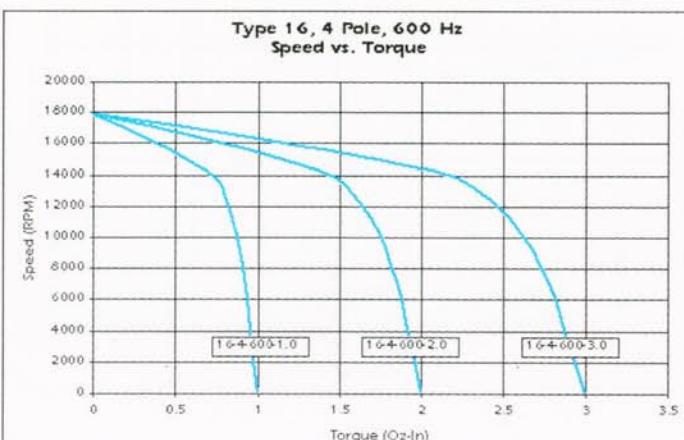
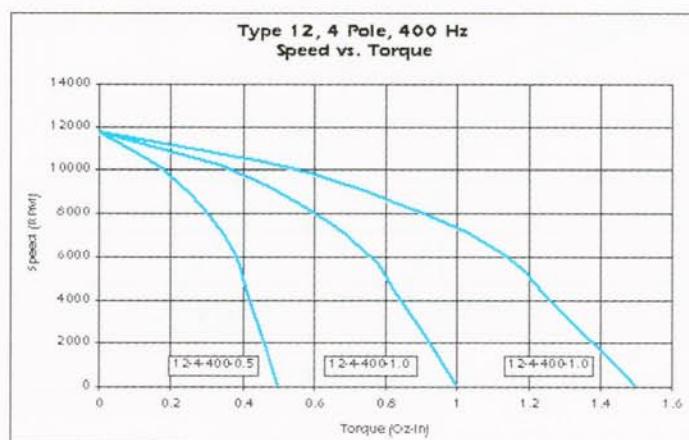
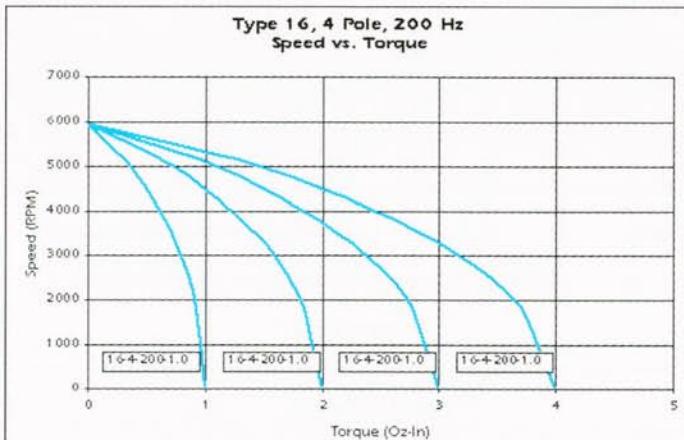
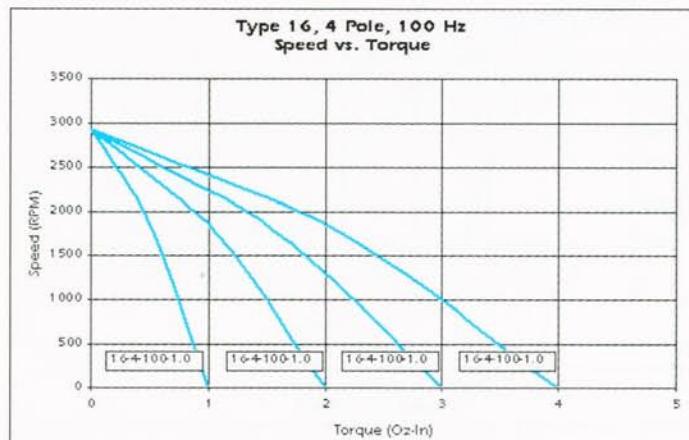


TYPE 16 , 4 POLE PERFORMANCE

Motor Code	Frequency	No Load Speed	Performance at Speed						Performance at Stall			
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Factor	
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts	Watts	Oz-In	mNm	Watts	
16-4-100-01	100	2900	0.75	5.0	1000	0.6	7	0.82	1.0	7.1	8	0.89
16-4-100-02	100	2900	1.50	11	1000	1.1	15	0.82	2.0	14	16	0.89
16-4-100-03	100	2950	2.25	16	1000	1.7	22	0.82	3.0	21	25	0.89
16-4-100-04	100	2950	3.00	21	1000	2.2	35	0.82	4.0	28	35	0.89
16-4-200-01	200	5900	0.75	5.0	3500	1.9	8	0.80	1.0	7.1	12	0.78
16-4-200-02	200	5900	1.50	11	3500	3.9	17	0.80	2.0	14	24	0.78
16-4-200-03	200	5950	2.25	16	3500	5.8	24	0.80	3.0	21	36	0.78
16-4-200-04	200	5950	3.00	21	3500	7.8	34	0.80	4.0	28	50	0.78
16-4-400-01	400	11500	0.75	5.0	8000	4.4	13	0.77	1.0	7.1	20	0.70
16-4-400-02	400	11700	1.50	11	8000	8.9	26	0.77	2.0	14	40	0.70
16-4-400-03	400	11800	2.25	16	8000	13.3	40	0.77	3.0	21	60	0.70
16-4-400-04	400	11800	3.00	21	8000	17.8	55	0.77	4.0	28	90	0.070
16-4-600-01	600	17500	0.75	5.0	13500	7.5	19	0.71	1.0	7.1	30	0.66
16-4-600-02	600	17500	1.50	11	13500	15.0	38	0.71	2.0	14	60	0.66
16-4-600-03	600	17500	2.25	16	13500	22.5	60	0.71	3.0	21	100	0.66

NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.



TYPE 16 , 6 POLE PERFORMANCE												
Motor Code	Frequency	No Load Speed	Performance at Speed							Performance at Stall		
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Input	Power Factor
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts		Oz-In	mNm	Watts	Power Factor
16-6-100-01	100	1875	0.75	5.0	650	0.6	7	0.82	1.0	7.1	8	0.89
16-6-100-02	100	1900	1.50	11	650	1.1	15	0.82	2.0	14	16	0.89
16-6-100-03	100	1925	2.25	16	650	1.7	22	0.82	3.0	21	25	0.89
16-6-100-04	100	1925	3.00	21	650	2.2	35	0.82	4.0	28	35	0.89

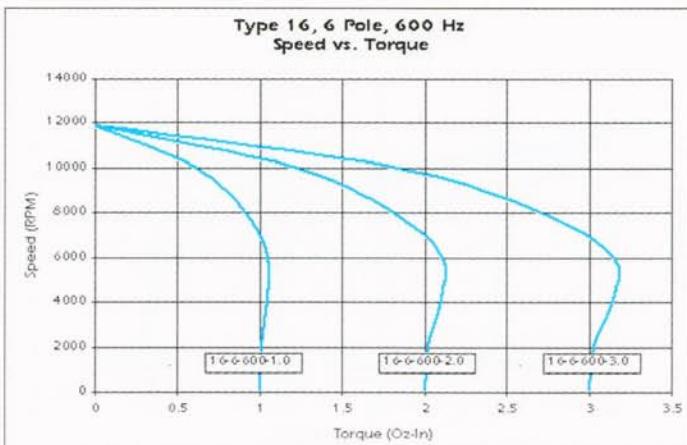
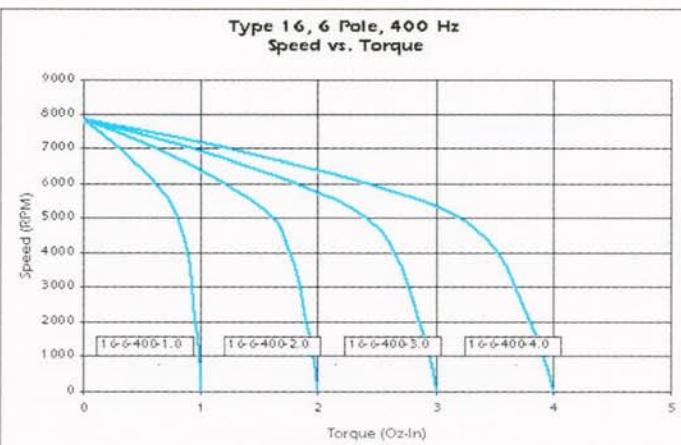
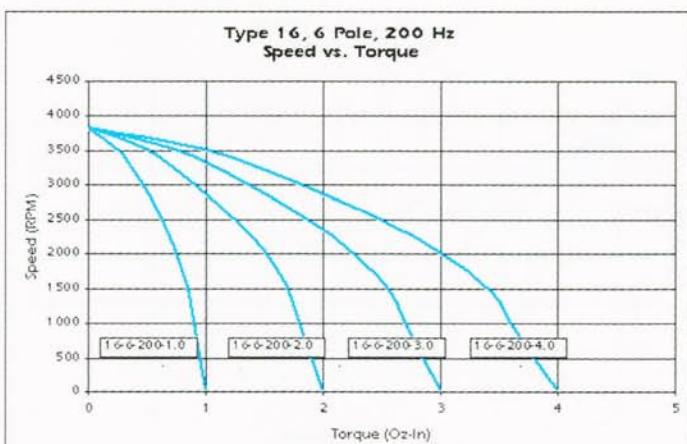
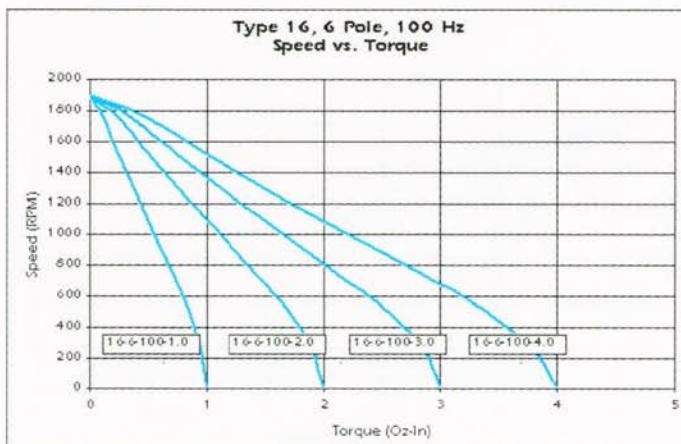
16-6-200-01	200	3800	0.75	5.0	2000	1.9	8	0.78	1.0	7.1	12	0.78
16-6-200-02	200	3850	1.50	11	2000	3.9	16	0.78	2.0	14	24	0.78
16-6-200-03	200	3850	2.25	16	2000	5.8	24	0.78	3.0	21	36	0.78
16-6-200-04	200	3850	3.00	21	2000	7.8	32	0.78	4.0	28	50	0.78

16-6-400-01	400	7750	0.75	5.0	5500	4.4	11	0.65	1.0	7.1	20	0.70
16-6-400-02	400	7800	1.50	11	5500	8.9	22	0.65	2.0	14	40	0.70
16-6-400-03	400	7800	2.25	16	5500	13.3	33	0.65	3.0	21	60	0.70
16-6-400-04	400	7800	3.00	21	5500	17.8	45	0.65	4.0	28	90	0.070

16-6-600-01	600	11700	0.75	5.0	9500	7.5	15	0.60	1.0	7.1	30	0.62
16-6-600-02	600	11800	1.50	11	9500	15.0	30	0.60	2.0	14	60	0.62
16-6-600-03	600	11800	2.25	16	9500	22.5	45	0.60	3.0	21	100	0.62

NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.

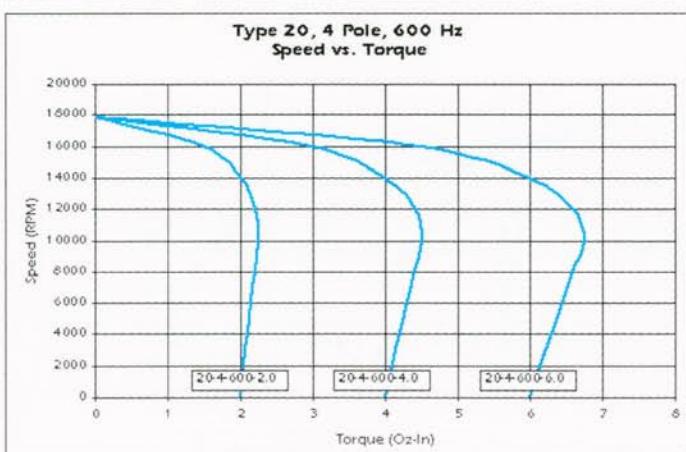
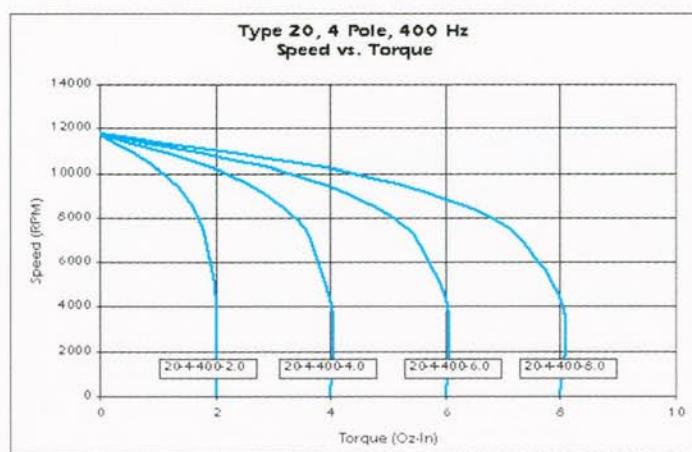
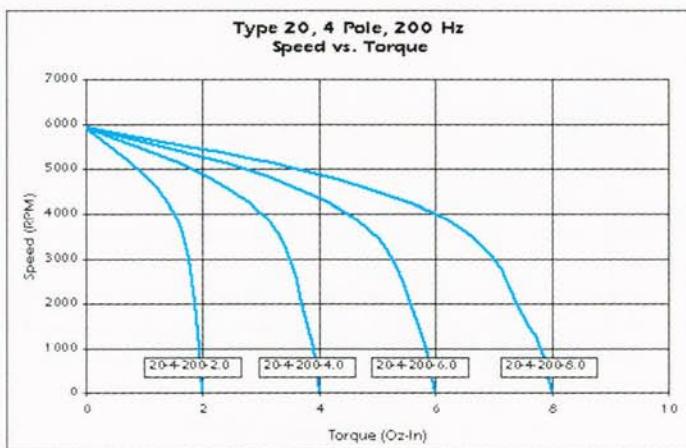
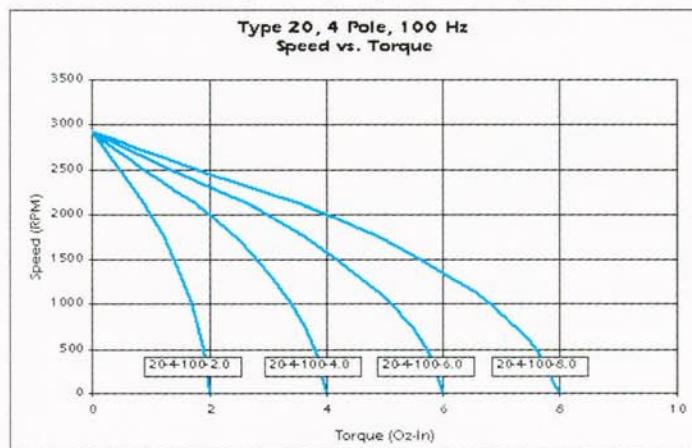


TYPE 20 , 4 POLE PERFORMANCE

Motor Code	Frequency	No Load Speed	Performance at Speed						Performance at Stall			
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Factor	
			Hz	RPM	Oz-In	mNm	RPM		Watts	Watts	Oz-In	
20-4-100-02	100	2950	1.5	11	1400	1.6	9	0.75	2.0	14	12	0.85
20-4-100-04	100	2950	3.0	21	1400	3.1	18	0.75	4.0	28	24	0.85
20-4-100-06	100	2960	4.5	32	1400	4.7	27	0.75	6.0	42	36	0.85
20-4-100-08	100	2960	6.0	42	1400	6.2	35	0.75	8.0	56	48	0.85
20-4-200-02	200	5900	1.5	11	4000	4.4	13	0.60	2.0	14	20	0.75
20-4-200-04	200	5900	3.0	21	4000	8.9	25	0.60	4.0	28	40	0.75
20-4-200-06	200	5950	4.5	32	4000	13.3	38	0.60	6.0	42	60	0.75
20-4-200-08	200	5950	6.0	42	4000	17.8	52	0.60	8.0	56	72	0.75
20-4-400-02	400	11900	1.5	11	9000	10.0	24	0.59	2.0	14	40	0.60
20-4-400-04	400	11900	3.0	21	9000	20.0	48	0.59	4.0	28	80	0.60
20-4-400-06	400	11950	4.5	32	9000	30.0	75	0.59	6.0	42	120	0.60
20-4-400-08	400	11950	6.0	42	9000	40.0	100	0.59	8.0	56	180	0.60
20-4-600-02	600	17800	1.5	11	14000	15.5	32	0.56	2.0	14	65	0.51
20-4-600-04	600	17900	3.0	21	14000	31.1	65	0.56	4.0	28	133	0.51
20-4-600-06	600	17900	4.5	32	14000	46.6	100	0.56	6.0	42	200	0.51

NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.



TYPE 20 , 6 POLE PERFORMANCE												
Motor Code	Frequency	No Load Speed	Performance at Speed							Performance at Stall		
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Input	Power Factor
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts		Oz-In	mNm	Watts	
20-6-100-02	100	1960	1.5	11	750	0.8	9	0.83	2.0	14	11	0.85
20-6-100-04	100	1950	3.0	21	750	1.7	18	0.83	4.0	28	22	0.85
20-6-100-06	100	1960	4.5	32	750	2.5	27	0.83	6.0	42	33	0.85
20-6-100-08	100	1960	6.0	42	750	3.3	35	0.83	8.0	56	44	0.85

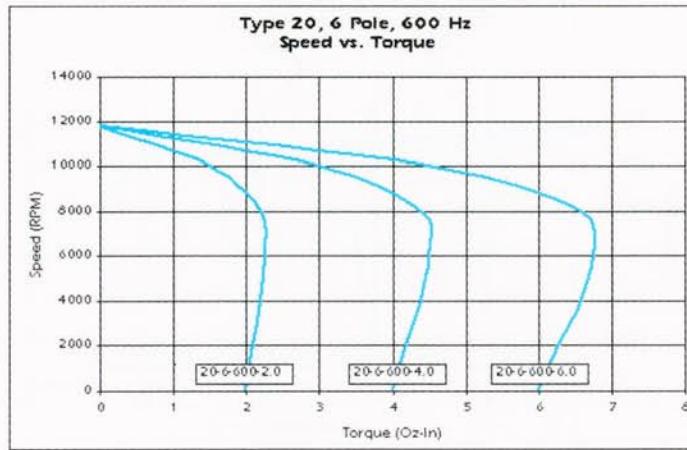
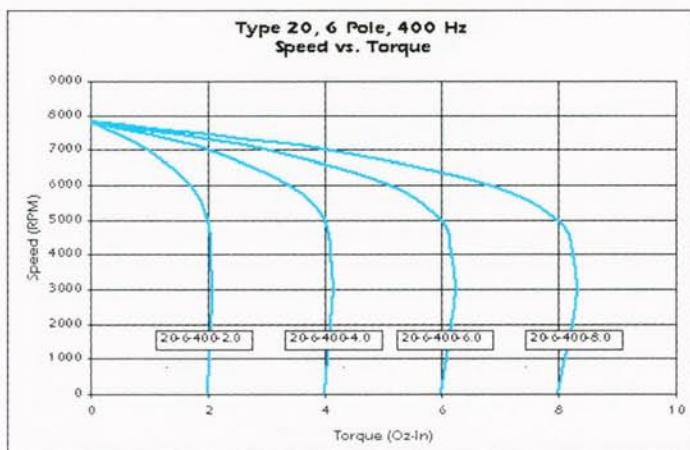
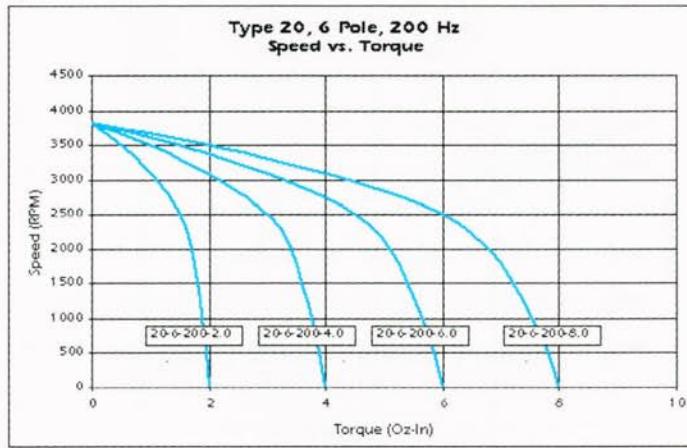
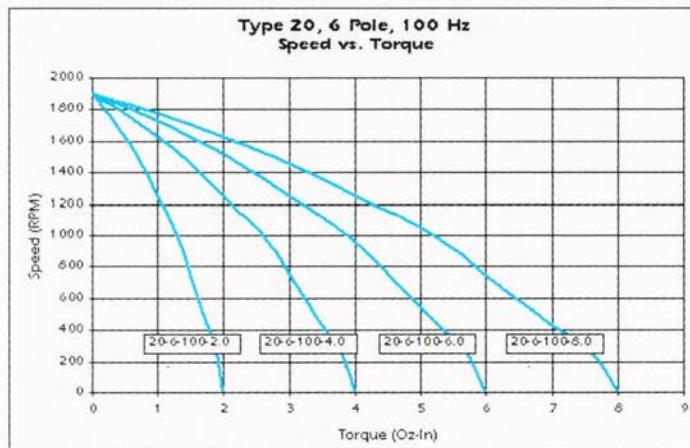
20-6-200-02	200	3950	1.5	11	2500	2.8	13	0.75	2.0	14	19	0.75
20-6-200-04	200	3950	3.0	21	2500	5.5	25	0.75	4.0	28	38	0.75
20-6-200-06	200	3950	4.5	32	2500	8.3	38	0.75	6.0	42	57	0.75
20-6-200-08	200	3950	6.0	42	2500	11.1	52	0.75	8.0	56	76	0.75

20-6-400-02	400	7900	1.5	11	6250	6.9	24	0.60	2.0	14	30	0.60
20-6-400-04	400	7900	3.0	21	6250	13.9	48	0.60	4.0	28	60	0.60
20-6-400-06	400	7950	4.5	32	6250	20.8	75	0.60	6.0	42	90	0.60
20-6-400-08	400	7950	6.0	42	6250	27.7	100	0.60	8.0	56	120	0.60

20-6-600-02	600	11800	1.5	11	10000	11.1	32	0.51	2.0	14	44	0.51
20-6-600-04	600	11900	3.0	21	10000	22.2	65	0.51	4.0	28	88	0.51
20-6-600-06	600	11900	4.5	32	10000	33.3	100	0.51	6.0	42	140	0.51

NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.

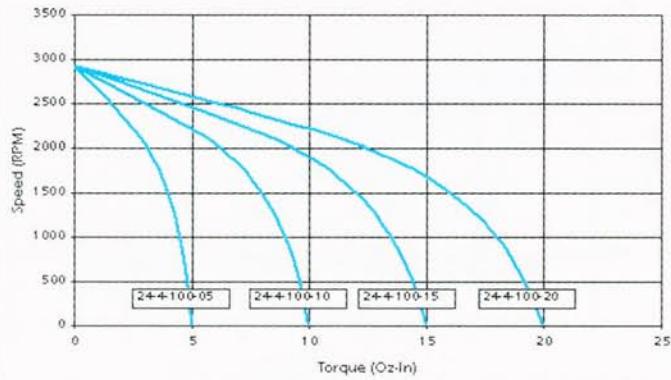
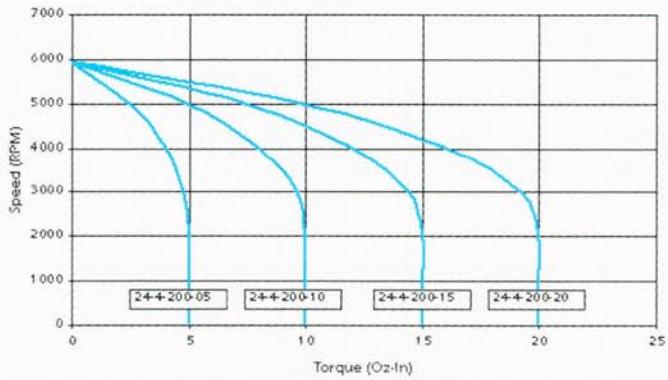
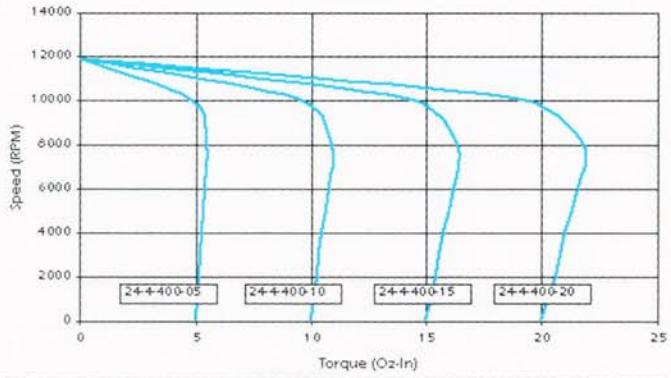
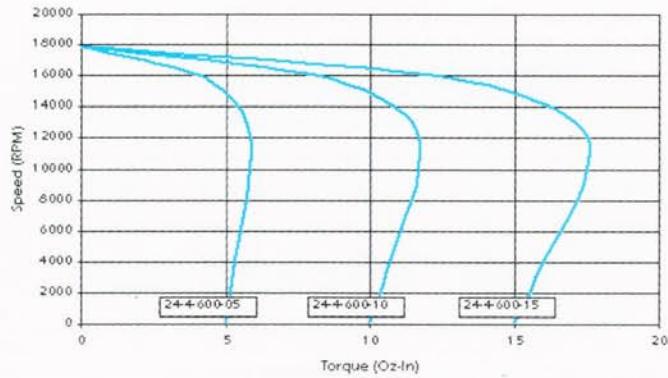


TYPE 24 , 4 POLE PERFORMANCE

Motor Code	Frequency	No Load Speed	Performance at Speed						Performance at Stall			
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Factor	
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts	Oz-In	mNm	Watts		
24-4-100-05	100	2950	4.0	28	1500	4.4	15	0.70	5	35	23	0.74
24-4-100-10	100	2950	8.0	56	1500	8.9	30	0.70	10	71	46	0.74
24-4-100-15	100	2950	12.0	85	1500	13.3	45	0.70	15	106	70	0.74
24-4-100-20	100	2950	16.0	113	1500	17.8	60	0.70	20	141	95	0.74
24-4-200-05	200	5950	4.0	28	4000	11.8	25	0.65	5	35	45	0.68
24-4-200-10	200	5950	8.0	56	4000	23.7	50	0.65	10	71	90	0.68
24-4-200-15	200	5950	12.0	85	4000	35.5	75	0.65	15	106	135	0.68
24-4-200-20	200	5950	16.0	113	4000	47.3	100	0.65	20	141	180	0.68
24-4-400-05	400	11850	4.0	28	10500	31.1	60	0.59	5	35	95	0.53
24-4-400-10	400	11850	8.0	56	10500	62.1	120	0.59	10	71	190	0.53
24-4-400-15	400	11900	12.0	85	10500	93.2	180	0.59	15	106	285	0.53
24-4-400-20	400	11900	16.0	113	10500	124.3	240	0.59	20	141	400	0.53
24-4-600-05	600	17800	4.0	28	16000	47.3	84	0.52	5	35	140	0.47
24-4-600-10	600	17800	8.0	56	16000	94.7	165	0.52	10	71	300	0.47
24-4-600-15	600	17900	12.0	85	16000	142.0	255	0.52	15	106	450	0.47

NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.

**Type 24, 4 Pole, 100 Hz
Speed vs. Torque**

**Type 24, 4 Pole, 200 Hz
Speed vs. Torque**

**Type 24, 4 Pole, 400 Hz
Speed vs. Torque**

**Type 24, 4 Pole, 600 Hz
Speed vs. Torque**


TYPE 24 , 6 POLE PERFORMANCE												
Motor Code	Frequency	No Load Speed	Performance at Speed						Performance at Stall			
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Factor	
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts		Oz-In	mNm	Watts	
24-6-100-05	100	1950	4.0	28	750	2.2	17	0.70	5	35	20	0.74
24-6-100-10	100	1950	8.0	56	750	4.4	35	0.70	10	71	42	0.74
24-6-100-15	100	1960	12.0	85	750	6.7	55	0.70	15	106	63	0.74
24-6-100-20	100	1960	16.0	113	750	8.9	75	0.70	20	141	90	0.74

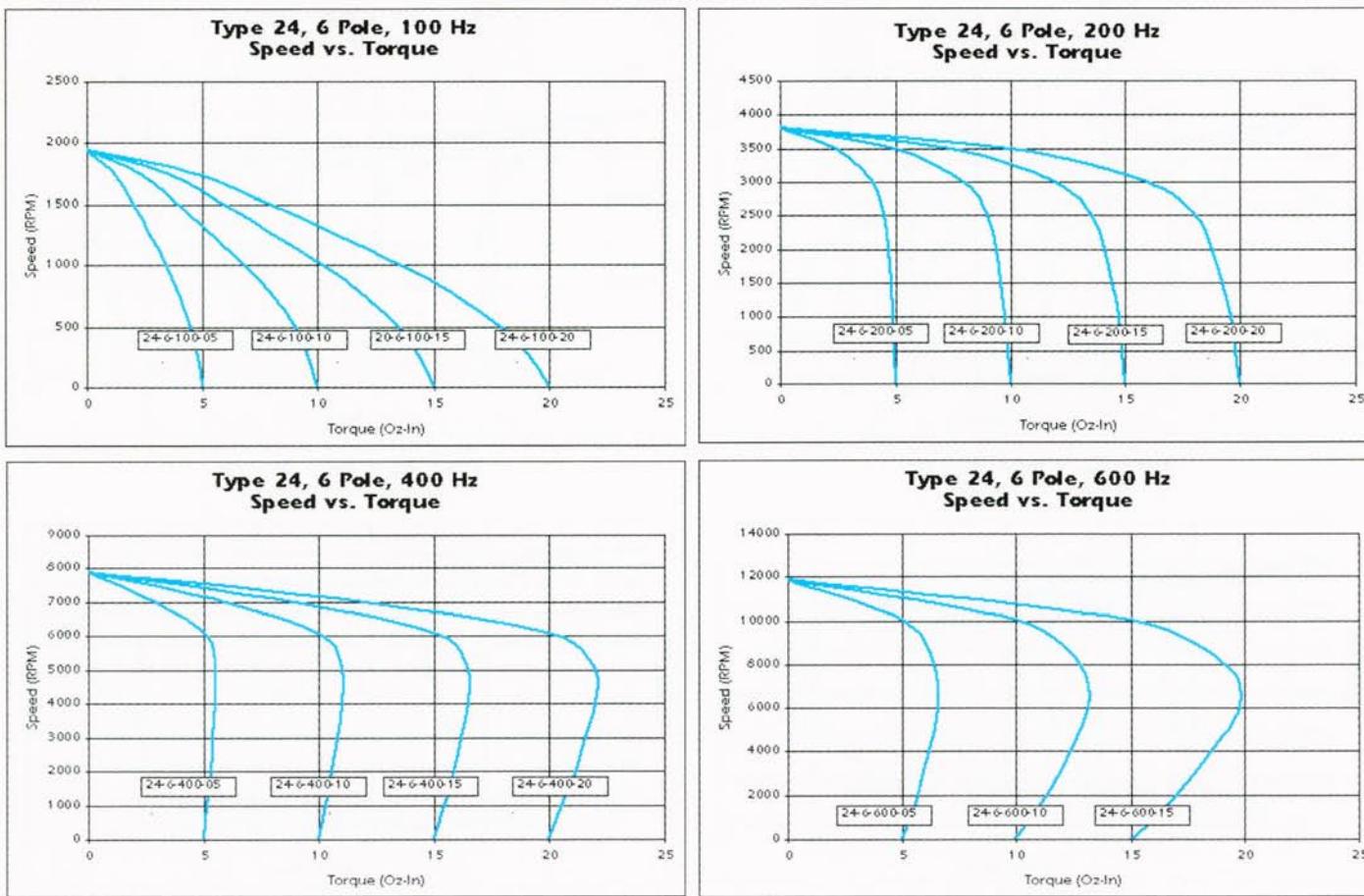
24-6-200-05	200	3950	4.0	28	3000	8.9	30	0.65	5	35	40	0.68
24-6-200-10	200	3950	8.0	56	3000	17.8	60	0.65	10	71	80	0.68
24-6-200-15	200	3950	12.0	85	3000	26.6	87	0.65	15	106	120	0.68
24-6-200-20	200	3950	16.0	113	3000	35.5	125	0.65	20	141	165	0.68

24-6-400-05	400	7900	4.0	28	6250	18.5	55	0.59	5	35	80	0.53
24-6-400-10	400	7900	8.0	56	6250	37.0	105	0.59	10	71	160	0.53
24-6-400-15	400	7900	12.0	85	6250	55.5	155	0.59	15	106	245	0.53
24-6-400-20	400	7950	16.0	113	6250	74.0	210	0.59	20	141	325	0.53

24-6-600-05	600	11800	4.0	28	10500	31.1	70	0.52	5	35	125	0.47
24-6-600-10	600	11900	8.0	56	10500	62.1	135	0.52	10	71	250	0.47
24-6-600-15	600	11900	12.0	85	10500	93.2	210	0.52	15	106	400	0.47

NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.



TYPE 32 , 4 POLE PERFORMANCE

Motor Code	Frequency	No Load Speed	Performance at Speed						Performance at Stall		
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Factor
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts		Oz-In	mNm	Watts
32-4-100-10	100	2950	9.0	64	1650	11.0	34	0.81	10	71	45
32-4-100-20	100	2950	18.0	127	1650	22.0	68	0.81	20	141	90
32-4-100-30	100	2950	27.0	191	1650	33.0	105	0.81	30	212	135
32-4-100-40	100	2960	26.0	254	1650	44.0	140	0.81	40	282	180

32-4-200-10	200	5900	9.0	64	4750	31.6	60	0.75	10	71	90	0.65
32-4-200-20	200	5900	18.0	127	4750	63.2	120	0.75	20	141	180	0.65
32-4-200-30	200	5950	27.0	191	4750	94.9	180	0.75	30	212	270	0.65
32-4-200-40	200	5950	26.0	254	4750	126.5	240	0.75	40	282	360	0.65

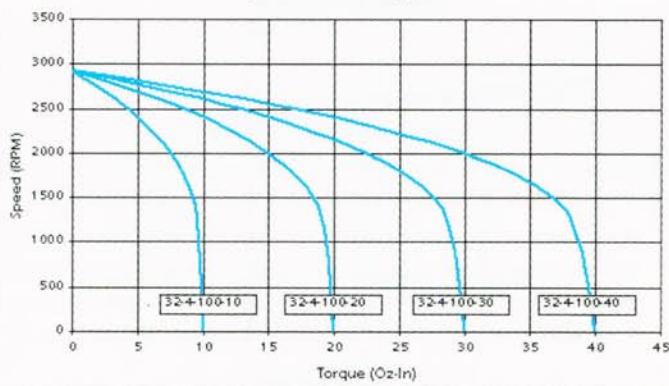
32-4-400-10	400	11900	9.0	64	11000	73.2	124	0.70	10	71	220	0.53
32-4-400-20	400	11900	18.0	127	11000	146.4	240	0.70	20	141	440	0.53
32-4-400-30	400	11950	27.0	191	11000	219.7	360	0.70	30	212	660	0.53
32-4-400-40	400	11950	26.0	254	11000	292.9	480	0.70	40	282	950	0.53

32-4-600-10	600	17800	9.0	64	16500	109.8	200	0.66	10	71	420	0.50
32-4-600-20	600	17900	18.0	127	16500	219.7	400	0.66	20	141	890	0.50
32-4-600-30	600	17900	27.0	191	16500	329.5	600	0.66	30	212	1250	0.50

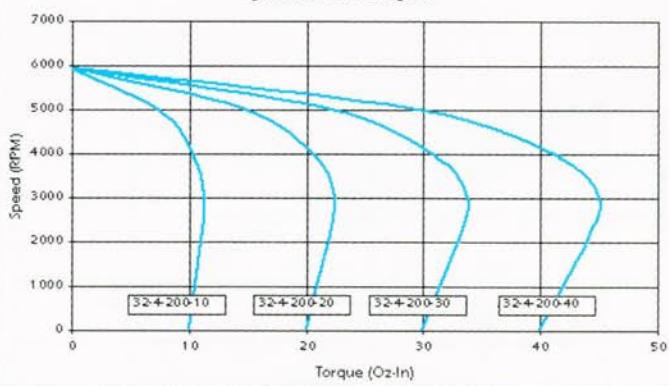
NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.

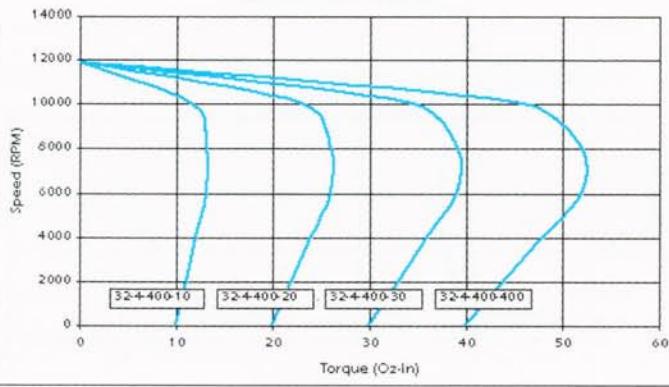
Type 32, 4 Pole, 100 Hz
Speed vs. Torque



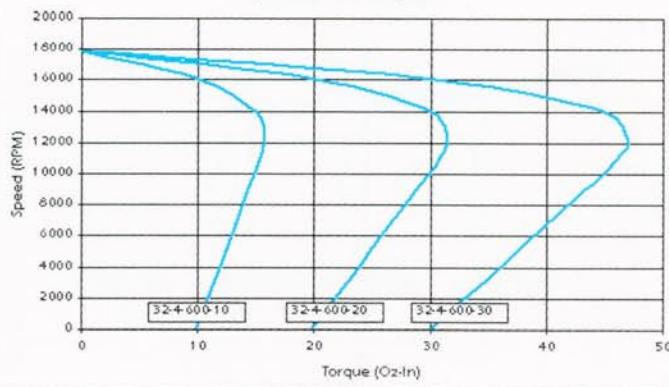
Type 32, 4 Pole, 200 Hz
Speed vs. Torque



Type 32, 4 Pole, 400 Hz
Speed vs. Torque



Type 32, 4 Pole, 600 Hz
Speed vs. Torque



TYPE 32 , 6 POLE PERFORMANCE												
Motor Code	Frequency	No Load Speed	Performance at Speed							Performance at Stall		
			Torque		Speed	Power Output	Power Input	Power Factor	Torque		Power Input	Power Factor
	Hz	RPM	Oz-In	mNm	RPM	Watts	Watts	Power Factor	Oz-In	mNm	Watts	Power Factor
32-6-100-10	100	1950	9.0	64	1100	7.3	20	0.73	10	71	33	0.74
32-6-100-20	100	1950	18.0	127	1100	14.6	40	0.73	20	141	66	0.74
32-6-100-30	100	1950	27.0	191	1100	22.0	62	0.73	30	212	100	0.74
32-6-100-40	100	1950	26.0	254	1100	29.3	85	0.73	40	282	135	0.74

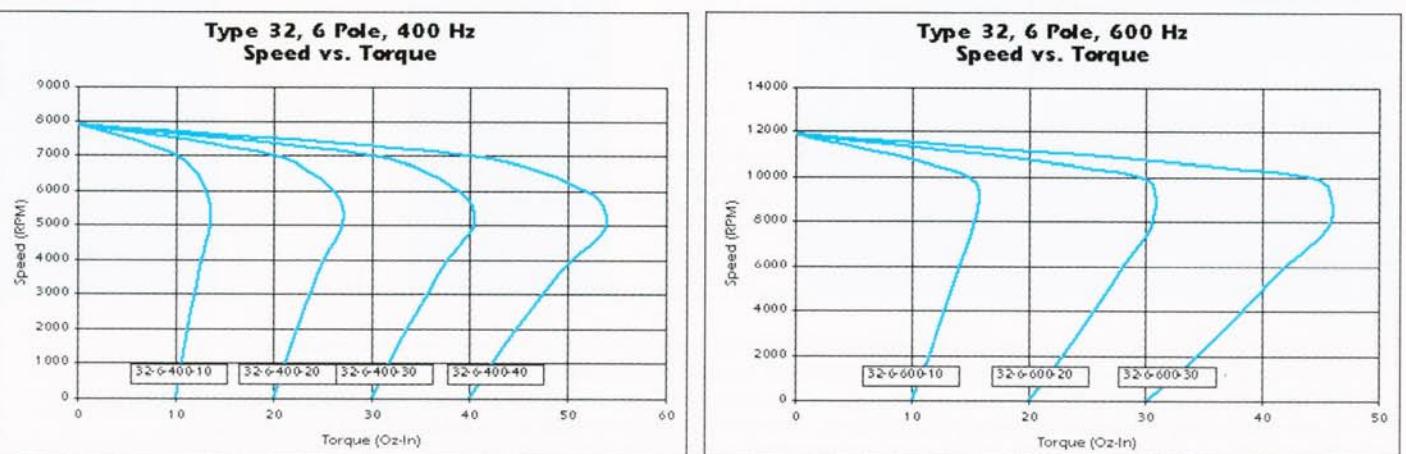
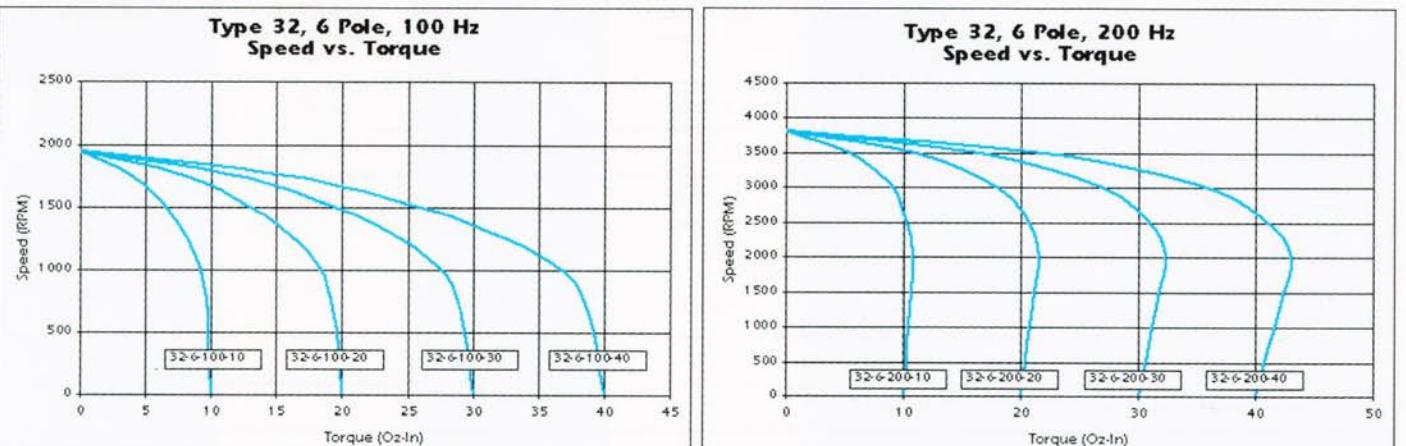
32-6-200-10	200	3900	9.0	64	3100	20.6	42	0.68	10	71	65	0.65
32-6-200-20	200	3950	18.0	127	3100	41.3	84	0.68	20	141	130	0.65
32-6-200-30	200	3950	27.0	191	3100	61.9	125	0.68	30	212	200	0.65
32-6-200-40	200	3950	26.0	254	3100	82.5	165	0.68	40	282	285	0.65

32-6-400-10	400	7900	9.0	64	7250	48.3	85	0.63	10	71	145	0.48
32-6-400-20	400	7900	18.0	127	7250	96.5	170	0.63	20	141	290	0.48
32-6-400-30	400	7950	27.0	191	7250	144.8	255	0.63	30	212	440	0.48
32-6-400-40	400	7950	26.0	254	7250	193.0	350	0.63	40	282	600	0.48

32-6-600-10	600	11800	9.0	64	11000	73.2	135	0.59	10	71	220	0.44
32-6-600-20	600	11900	18.0	127	11000	146.4	270	0.59	20	141	460	0.44
32-6-600-30	600	11900	27.0	191	11000	219.7	430	0.59	30	212	700	0.44

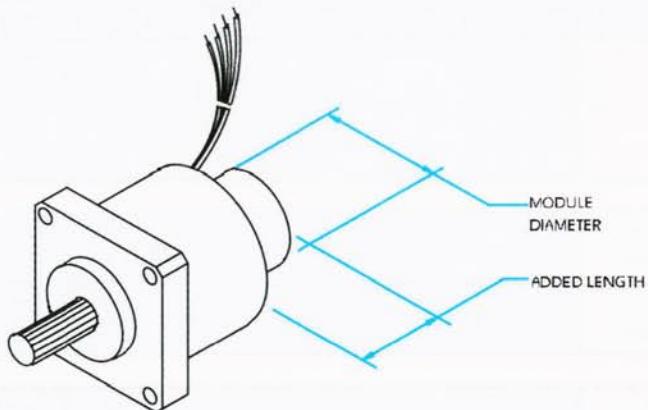
NOTES:

1. Performance tabulated at +25° C unit temperature.
2. Windings for **sinusoidal** or **square wave** voltage sources as required.
3. Operating voltages as required.
4. Single phase performance and capacitor value information available on request.
5. Unit continuous operating temperature range: -80° to +225° C.



Optional Integral Components

Tachometers, Accelerometers, Brakes

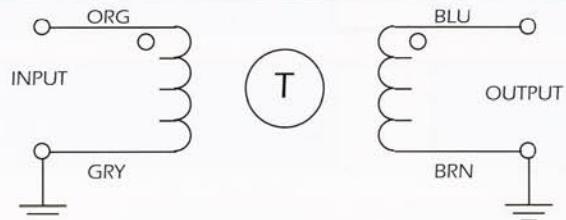


TACHOMETERS - DAMPING

Description / Applications:

AC Damping Tachometers are ideal rate transducers for high accuracy closed position loop applications where high forward loop gains and inner loop stability are critical.

The output voltage of AC tachometers are proportional to the angular velocity of the motor rotor shaft, and the voltage signal is phase sensitive to the direction of rotation. This information may be used for servo stability requirements, closed velocity applications, or control system information purposes.



Output voltage in phase with excitation for CW rotation, viewing shaft

Type —>	03S2.5	03S0.4	05S2.5	05S0.4
Excitation Voltage	Volts RMS	10	26	10
Frequency	Hertz	2500	400	2500
Untuned Current	Amps RMS	0.045	0.016	0.050
Tuned Current	Amps RMS	0.040	0.014	0.045
Output Voltage @ +25° C	Volts/1000 RPM	0.125	0.125	0.250
Temperature Coefficient (Output Voltage Drop/°C Rise)	%/°C	0.15	0.30	0.15
Total Null Voltage	mVolts RMS	15	15	25
In Phase Null Voltage	mVolts RMS	10	10	10
Output Load	Ohms	50,000	50,000	50,000
Added Length	Inches [mm]	0.600 [15.2]	0.600 [15.2]	0.600 [15.2]
Tachometer Diameter	Inches [mm]	0.750 [19.1]	0.750 [19.1]	1.250 [31.8]
Added Inertia	oz-in-sec ² [kg-m ²]	2.8 E-06 [2.0 E-08]	2.8 E-06 [2.0 E-08]	5.5 E-05 [3.8 E-07]
Added Weight	Oz [kg]	0.75 [0.021]	0.75 [0.021]	2.3 [0.065]

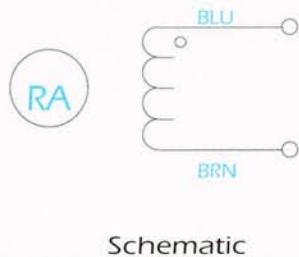
NOTES:

1. See Rotary Transducer Engineering Reference Data brochure for additional tachometer options.
2. Other voltages, frequencies, and performance data available on request.
3. Tachometers may be sold as a stand alone item, or integrally mounted to a motor assembly as shown above.
4. Phase shift compensation required for 2.5 kHz. tachometer demodulation. Contact CDA for information.

ROTARY ACCELEROMETERS

Description / Application:

Rotary Accelerometers (RAs) provide a DC output voltage in proportion to the rotary acceleration of the motor shaft. These permanent magnet devices **require no excitation or input power**. RAs are ideal components to achieve a higher order servo stability performance characteristic. The acceleration signal may be used alone, or the voltage may be integrated to provide velocity 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 networks. See Page 25 for a Functional Block Diagram of a Rotary Accelerometer in a Closed Loop Servo Application



Schematic

TYPE —>		03ACC	05ACC
Output Voltage	V/100kRAD/sec ²	0.60	2.3
Output Load	Ohms	50,000	50,000
Added Length	Inches [mm]	0.600 [15.3]	0.600 [15.3]
Accelerometer Diameter	Inches [mm]	0.750 [19.1]	1.250 [31.8]
Added Inertia	Oz-In-sec ² [kg-m ²]	2.8 E-06 [2.0E-08]	5.5 E-05 [3.8 E-07]
Added Weight	Oz [kg]	0.750 [0.021]	2.3 [0.065]

Notes:

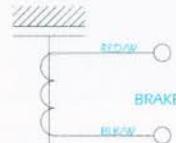
1. See Transducer Application Data Catalog or Rotary Accelerometer Application Data Flyer for additional information.
2. Tabulated performance at +25° C.

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.



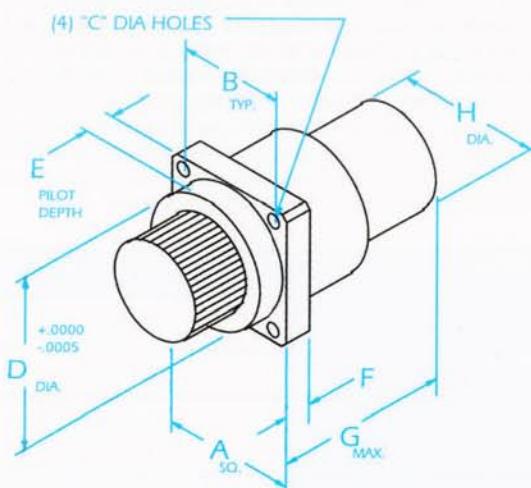
Schematic

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 14.
3. Listed performance at +25° C.

Motor - Gearhead Composite Dimensions and Performance



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
DO	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
FO	40	5	10	2.500	2.062	0.206	1.4375	0.313	0.500	2.875	2.500	47	1.3
HD	40	22	107	2.500	2.062	0.206	1.8750	0.375	0.500	3.601	2.500	61	1.4
JF	40	20	70	2.500	2.062	0.206	2.4375	0.437	0.500	3.880	2.500	87	1.9
HO	48	5	10	3.000	3.000	0.266	1.8750	0.375	0.750	3.234	3.000	74	0.9
JF	48	20	70	3.000	3.000	0.266	2.4375	0.437	0.750	4.209	3.000	107	1.0
MH	48	18	61	3.000	3.000	0.266	2.9687	0.500	0.750	4.497	3.000	125	1.7

Notes:

1. Rate gearhead performance by the first letter of "Gearhead Type" tabulated. See the following 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. Dry film lubrication for cryogenic temperature operation available on request. Contact CDA's engineering department for information.

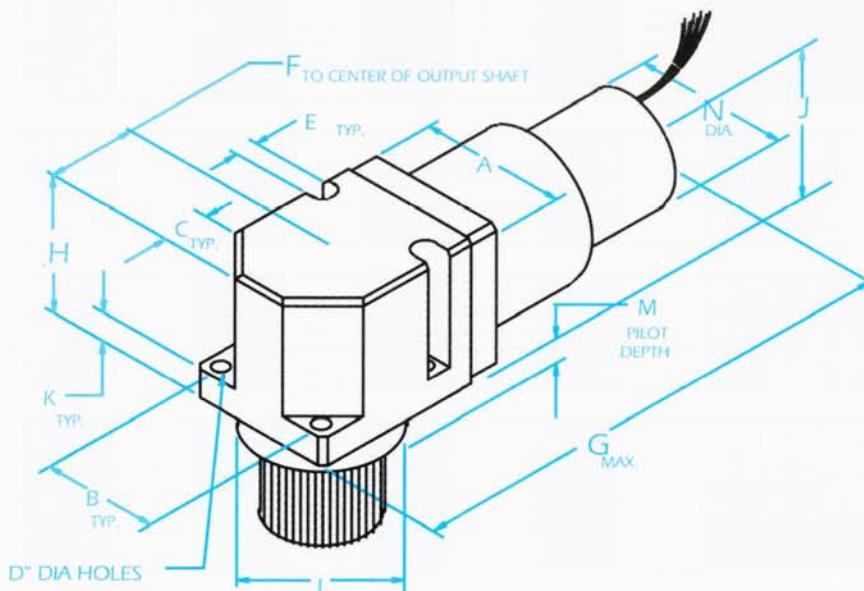
TYPE		RATIOS		System International Dimensions (In mm)								WEIGHT	TEMP.COEF.
GEARHEAD	MOTOR	FROM	TO	A	B	C	D	E	F	G	H	kg	(°C/Watt Loss)
AO	12	5	10	19.05	15.75	2.06	17.463	3.96	4.78	30.08	19.05	0.060	7.0
AA	12	25	100	19.05	15.75	2.06	17.463	3.96	4.78	44.30	19.05	0.085	7.0
CA	12	21	100	25.40	21.03	2.80	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
FO	40	5	10	63.50	52.37	5.23	36.513	7.95	12.70	73.00	63.50	1.33	1.3
HD	40	22	107	63.50	52.37	5.23	49.213	9.53	12.70	91.44	63.30	1.73	1.4
JF	40	20	70	63.50	52.37	5.23	61.913	11.10	12.70	98.54	63.50	2.45	1.9
H0	48	5	10	76.20	63.50	6.76	49.213	9.53	19.05	82.14	76.20	2.10	0.9
JF	48	20	70	76.20	63.50	6.76	61.913	11.10	19.05	107.0	76.20	3.09	1.0
MH	48	18	61	76.20	63.50	6.76	75.405	12.70	19.05	114.0	76.20	3.55	1.7

Notes:

- Rate gearhead performance by the first letter of "Gearhead Type" tabulated. See performance below.
- [Other gear ratios and mounting configurations are available on request.](#)
- Overall gearing efficiency = 90%.
- Temperature coefficient is °C rise per watt loss, while mounted on a 150 x 150 x 6 mm black aluminum plate.
- Dry film lubrication for cryogenic temperature operation is available on request. Contact CDA's engineering department for information.

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	

Motor / Right Angle Gearhead Composite Dimensions and Performance



IMPERIAL UNITS - DIMENSIONS IN INCHES																		
TYPE		RATIOS (SEE NOTE 2)		A	B	C	D	E	F	G	H	J	K	L	M	N	WEIGHT OZ.	TEMP. COEF. °C/WATT LOSS
GEARHEAD	MOTOR	FROM	TO															
ARA	12	46	187	0.750	0.620	0.229	0.081	0.140	0.375	2.129	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	2.68	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	2.834	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	3.593	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	4.000	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	2.3
JRF	32	30	129	2.500	2.060	0.750	0.206	0.430	1.250	5.750	2.562	1.312	0.500	2.4750	0.562	2.000	85	2.3
JRF	40	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	2.500	110	2.0
MRH	40	33	130	3.313	2.750	1.062	0.265	0.600	1.656	7.160	3.188	1.688	0.687	3.2500	0.750	2.500	160	2.0
MRH	48	33	130	3.313	2.750	1.062	0.265	0.600	1.656	7.160	3.188	1.688	0.687	3.2500	0.750	3.000	192	1.7

Notes:

1. Rate gearhead performance by the "Gearhead Type" tabulated. See following 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. Dry film lubrication for cryogenic temperature operation available on request. Contact CDA's engineering department for information.

6. "J" dimension is from mounting surface to the centerline of the motor body diameter.

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	62.58	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	68.06	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	82.10	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	90.54	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	95.00	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	109.1	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	116.3	52.37	26.97	9.53	50.165	12.07	50.80	1.48	2.3
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	63.50	2.84	2.0
MRH	40	33	130	84.15	69.85	26.97	6.73	15.24	42.06	166.7	80.97	42.87	17.44	82.550	19.05	63.50	4.55	2.0
MRH	48	33	130	84.15	69.85	26.97	6.73	15.24	42.06	181.4	80.97	42.87	17.44	82.550	19.05	76.20	5.50	1.7

Notes:

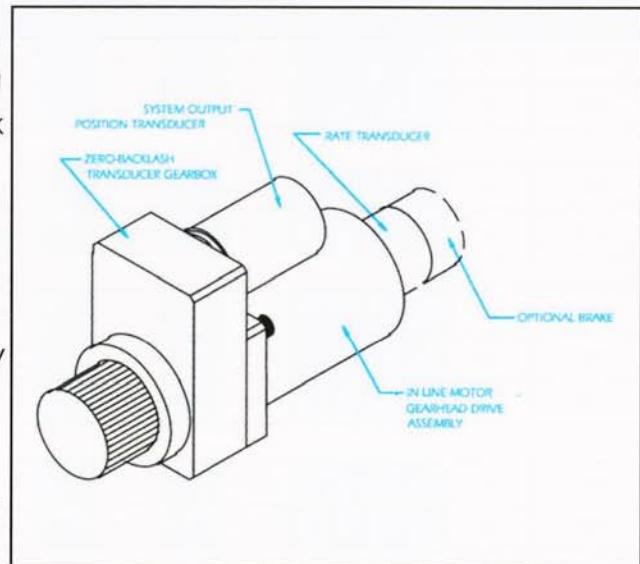
1. Rate gearhead performance by the "Gearhead Type" tabulated. See performance below.
2. Other gear ratios and mounting configurations are available on request.
3. Overall gearing efficiency = 85%.
4. Temperature coefficient is in °C rise per watt loss, while mounted on a 150 x 150 x 6 mm black aluminum plate.
5. Dry film lubrication for cryogenic temperature operation available on request. Contact CDA's engineering department for information.
6. "J" dimension is from mounting surface to the centerline of the motor body diameter.

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	

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.

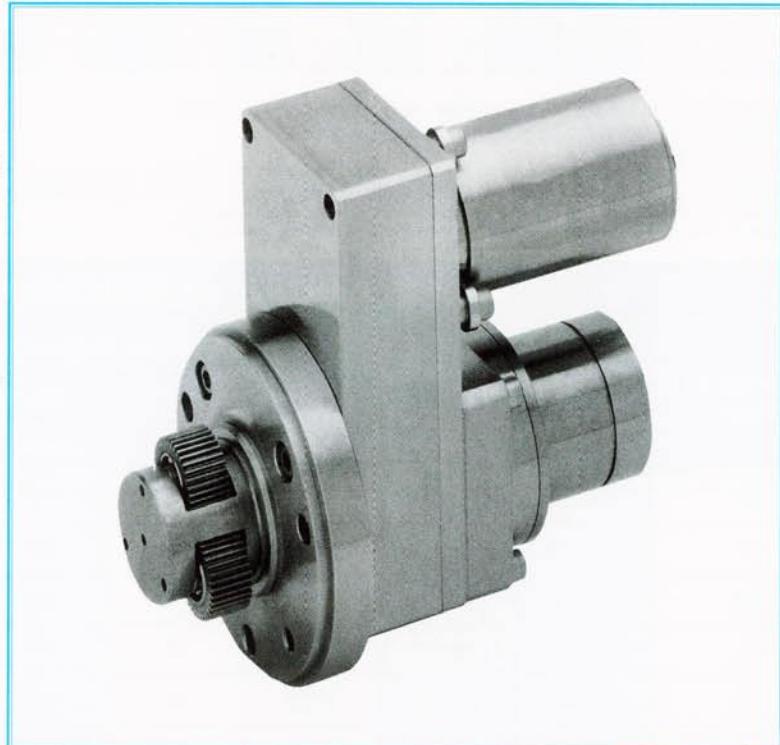
CDA has the ability to incorporate high speed rotary transducers, such as resolvers or accelerometers, which are integrally mounted to the motor. This information, coupled with the load position feedback, may provide enhanced motor performance, or "multiple speed" position information.



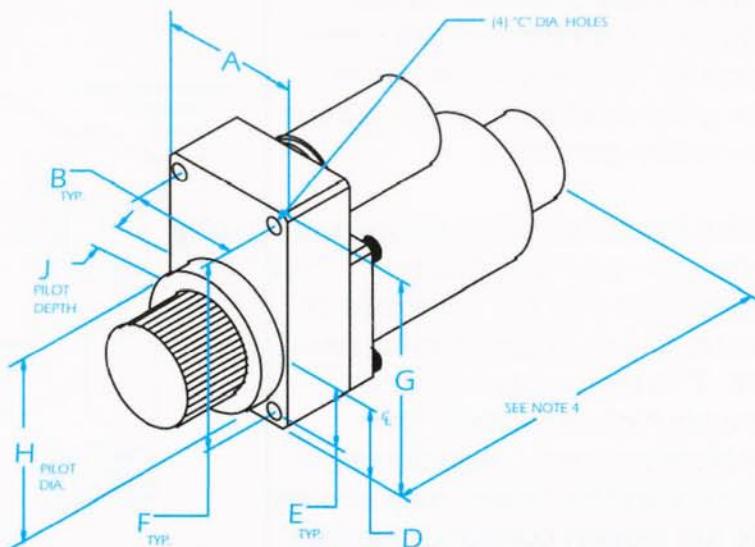
The flexibility of CDA's standard modular design concept allows the incorporation of multifunction controllable drive actuators, with application proven ruggedness and reliability. These actuator packages offer unlimited design features within standard inventoried piece parts and design concepts.

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



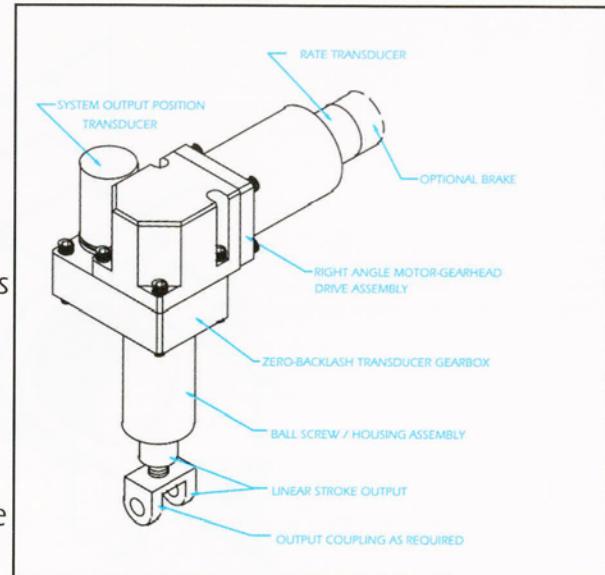
Imperial Units (In Inches)									
Gearbox Type	A	B	C	D	E	F	G	H	J
AT	0.750	0.620	0.081	0.375	0.310	1.937	2.110	0.6875	0.125
CT	1.000	0.828	0.113	0.500	0.414	1.953	2.125	0.9375	0.125
DT	1.250	1.030	0.140	0.625	0.515	1.864	2.062	1.1875	0.156
FT	1.500	1.250	0.150	0.750	0.625	2.125	2.375	1.4375	0.250
HT	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 Actuators

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.

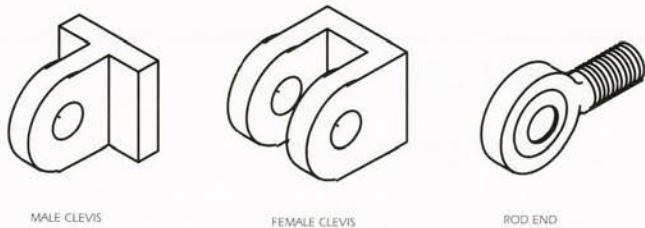
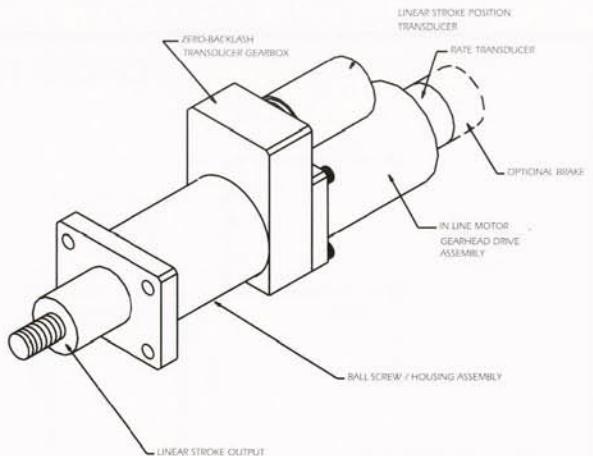


CDA has extended our modular design concepts for our rotary components to establish the same high standards for our linear actuators. These assemblies are extremely flexible in accommodating wide variations of linear stroke, force, and mounting configurations within these standards. The utilization of 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 maintaining 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.



MALE CLEVIS

FEMALE CLEVIS

ROD END

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:

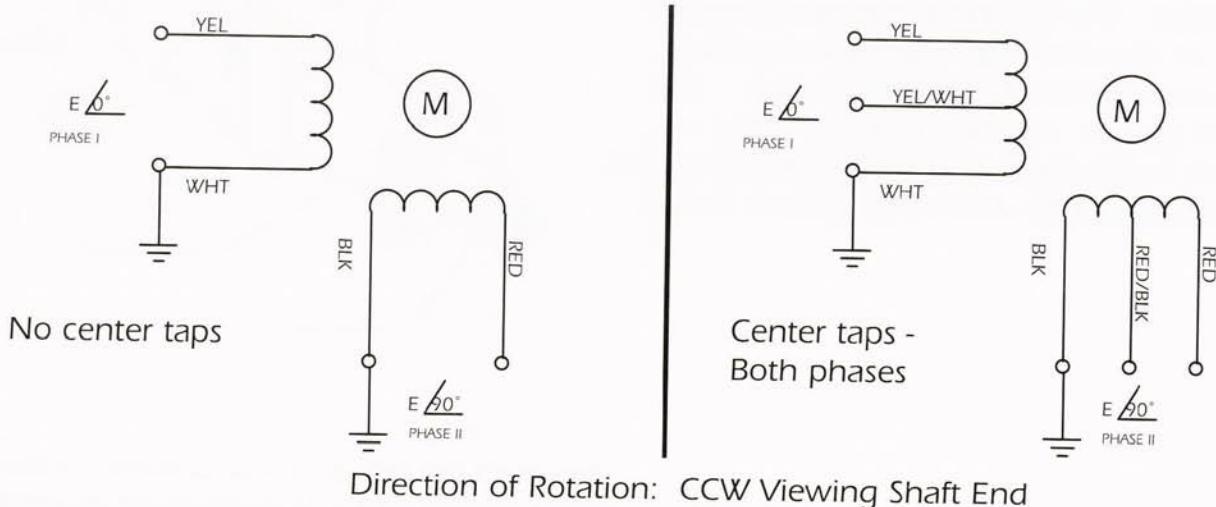
- * Anti-rotation provision
- * Ball screw with nut only
- * ACME Lead Screw with nut only
- * In-line, right angle, or "U" power drive configuration
- * Hard mounted connector



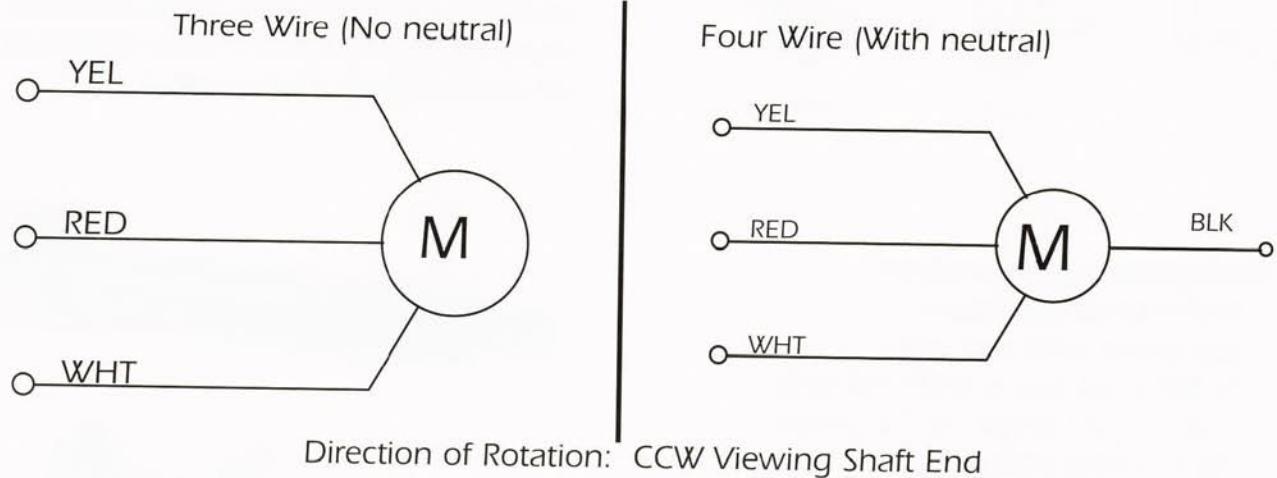
More options are shown in these photos. All of these custom end item configurations start with our standard motors, gearboxes, and thrust adapters. These mechanical "embellishments" allow flexibility for integration and installation of our standard products in a unique system application.

AC MOTOR PHASING DIAGRAMS

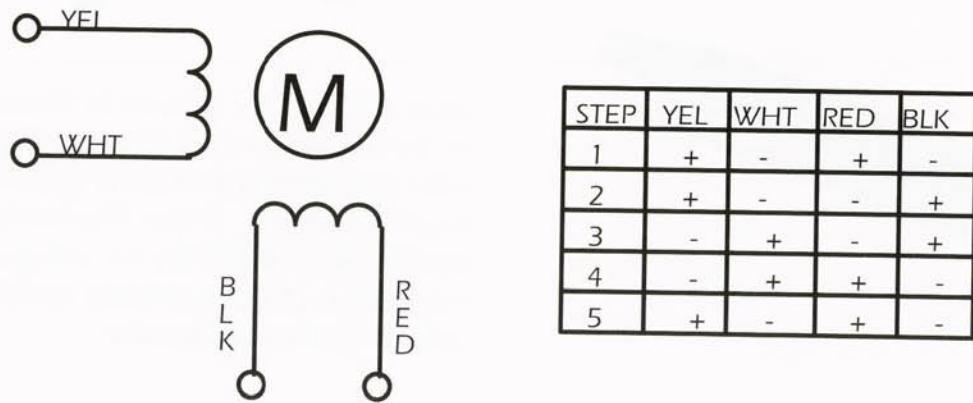
MOTOR- TWO PHASE OPERATION



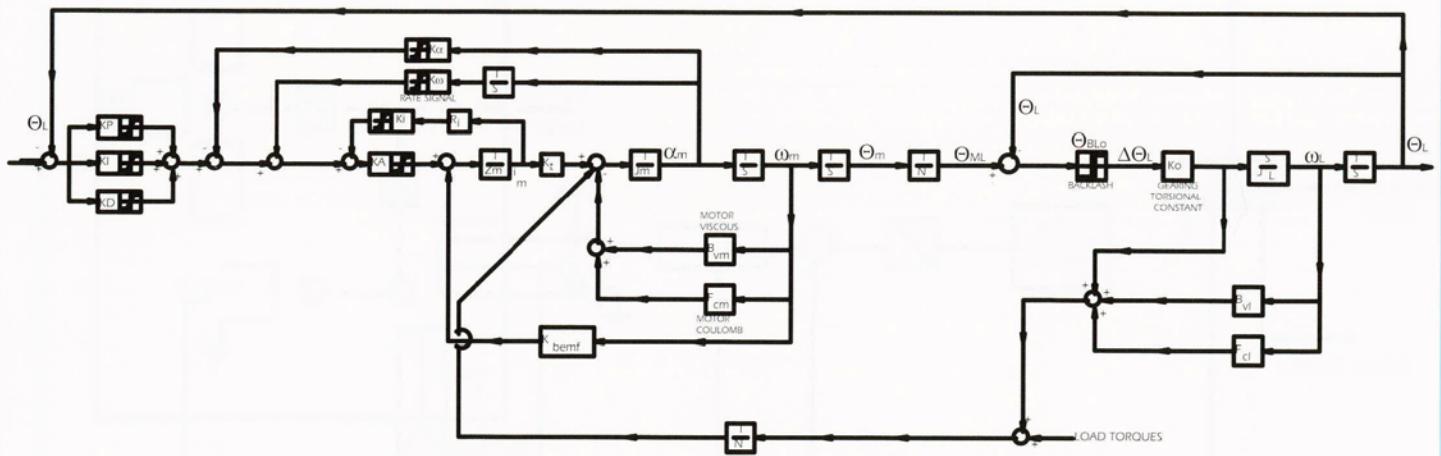
MOTOR- THREE PHASE OPERATION



MOTOR - SQUARE WAVE DRIVE OPERATION



Functional Block Diagram
 Brushless Permanent Magnet Servo Motor
 with Rotary Accelerometer Feedback
 and Integrated Velocity Damping



Where:

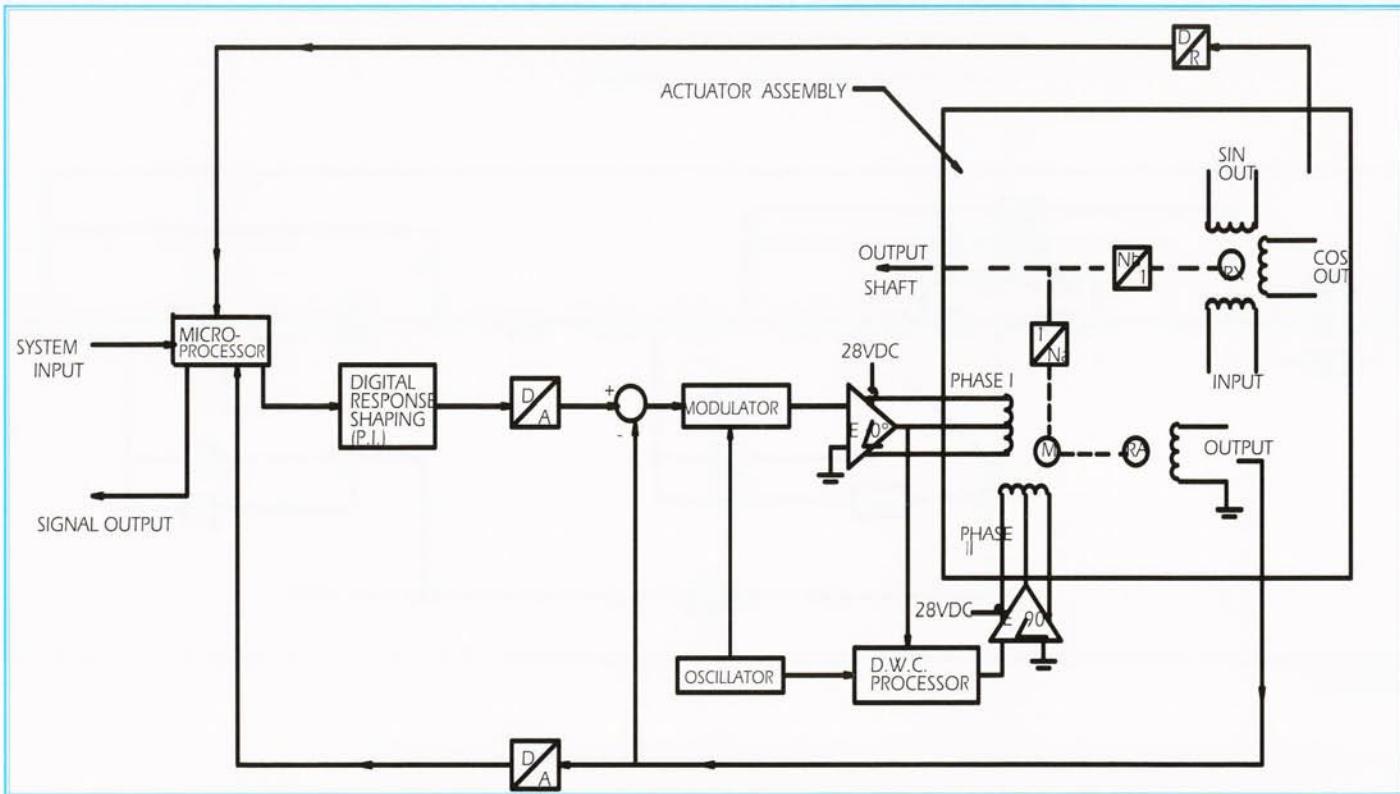
K_P = Proportional Gain of Error Signal
 K_α = Acceleration Signal Gain
 K_I = Current Feedback Gain
 R_i = Current Sense Resistor
 K_t = Motor Torque Constant
 B_{VM} = Motor Viscous Damping
 K_{bemf} = Motor Back emf Constant
 i_M = Motor Current
 α_M = Motor Acceleration
 θ_M = Motor Position
 θ_{IN} = Load Position Command

K_I = Integration Gain of Error Signal
 K_ω = Velocity Signal Gain
 K_A = Power Amplifier Gain
 Z_M = Motor Impedance ($R_o + j\omega L$)
 J_M = Motor Inertia
 F_{CM} = Motor Coulomb Friction
 s = Laplace Operator
 N = Gearhead Ratio
 ω_M = Motor Velocity
 θ_L = Load Position
 J_L = Load Inertia

The Rotary Accelerometer (RA) is an extremely useful component in high performance and / or high load inertia servo actuator systems. Since the RA requires no excitation or demodulation, the DC output may be directly Op-Amp integrated for an angular rate damping signal of the motor. This information, along with the angular acceleration signal provides tremendous flexibility in contouring the system response and controlling the transfer function. Although this block diagram shows a Brushless Motor, the RA feedback concept works equally well with an AC Induction Motor.

The Rotary Accelerometer can make the motor rotor inertia electronically "look" larger or smaller through this feedback technique. This electronic technique is like adding a variable electronic "flywheel" to the system, and provides a higher order effect, as compared to electronic damping through tachometer feedback. This may provide high forward loop gain, while maintaining a stable servo system. The electronic flywheel may be controlled to provide these characteristics dynamically in the system. Other advantages include acceleration control and disturbance attenuation. Contact CDA InterCorp's engineering department for additional information on RA benefits in servo systems.

Dual Winding Control AC Induction Motors



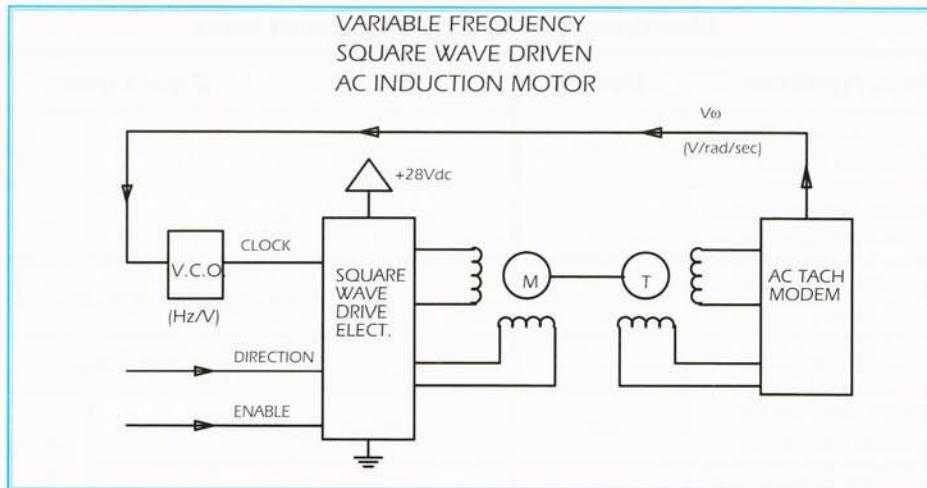
This functional block diagram is shown as a digital system. However, the concept and functionality of the Dual Winding Control (DWC) AC Induction Actuator will also work in an analog control system. In low to moderate power output servo systems, this concept will be more cost effective than a Brushless Permanent Magnet Actuator system. Additionally, this system will be more efficient than a Fixed Phase AC Induction Actuator.

The DWC processor, shown in the block diagram, is simply a full wave bridge to keep a constant polarity of the signal going into the Phase II amplifier. This provides phase sensitive actuation, so the actuator will reverse direction of rotation on command.

The block diagram also represents a servo actuator with integral load feedback information, and high-speed rotary acceleration feedback.



Variable Frequency, Square Wave Driven AC Induction Motors



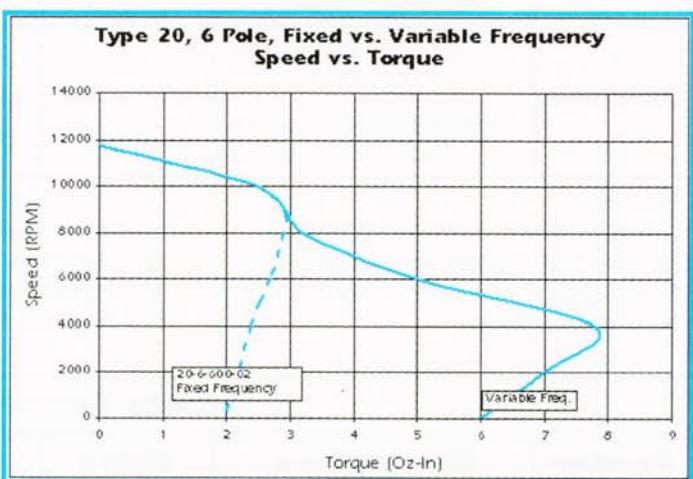
Variable Frequency, Square Wave Driven AC Induction Motors can significantly increase motor efficiency, torque capacity, and mechanical power output within a given motor frame size, while maintaining simple, cost efficient, high efficiency control electronics. This drive technique is recommended in moderate power output servo and open loop applications, as a cost effective alternative to Brushless P.M. motors, or a high reliability alternative to Brush type DC motors.

The schematic above shows velocity feedback of the motor rotor via the AC Tachometer. This velocity information is used to determine the operating frequency of the motor via the Voltage Control Oscillator (VCO). This simple variable frequency topology allows the actuator to operate at high frequencies at high speeds for high power output capacity, and low frequencies at low speeds for high torque per watt capacity.

The design engineer may select the frequency range of operation to optimize performance for a specific application. For instance, to obtain high power output capacity, the high end speed may operate to 600 Hz, while the low speed frequency may be limited to 100 Hz.

An important aspect of this drive scenario is the increase in power input as the speed reduces. Because the impedance of AC motors reduces as the frequency reduces, the power input at a constant voltage will increase, as the frequency and speed decreases. This characteristic effect may be minimized or eliminated by limiting the current to a predetermined value. This requires square wave drive power stages to have current limit capabilities, which most drivers have as an option.

Figure VFO is an actual Speed vs. Torque curve for a Type 20, 6 pole AC motor operated from 600 Hz. down to 100 Hz. **The variable frequency drive in this example has provided 200% more stall torque, at 25% less power input, than a fixed frequency 600 Hz drive would provide.** Additionally, the variable frequency provision achieves nearly 15 times the mechanical power output as compared to fixed frequency 100 Hz. operation. As shown in this curve, current limiting is recommended since the impedance of the motor decreases with decreasing frequency, the stall power might be too high for a given application. Other performance benefits are realized in this



example, such as maximum power output, peak torque, motor maximum efficiency, and motor effectiveness. Clearly, this simple drive circuitry provides considerable benefits over other AC drive methods, while using simple, high efficiency control electronics, with DC source voltages. This control method is a viable alternative to Brushless Permanent Magnet actuators and control requirements.

A tabulated comparison of the key characteristics of the variable frequency operation example over a fixed frequency 600 Hz and 100 Hz application. Call CDA's engineering department for a complete test report and additional information on variable frequency operation.

Parameter	Units	Variable Frequency Operation	Fixed 600 Hz. Operation	Fixed 100 Hz. Operation
Stall Torque	Oz-In	6.0	2.0	6.0
	mNm	42	14	42
Stall Power (for torque noted above)	Watts	33	44	33
Maximum Power Output	Watts	25	25	1.7

Actuation Performance Equations

Mechanical Output Equations				
Symbol	Description	Units	Equation	
P_o	Mechanical Power Output Imperial Units	Watts	$P_o = (T_L * \omega_L) / 1352$	(T_L in Oz-In, ω_L in RPM)
P_o	Mechanical Power Output System International	Watts	$P_o = T_L * \omega_L$	(T_L in Nm, ω_L in Rad/sec)
T_L	Torques Referred to the Load	Lb-In or Nm	$T_{L\max} = (J_L \alpha_L + J_m N^2 \alpha_L + B_L \omega_L + K_L \theta_L + F_c + Mg_L) \max$	
N	Gear Ratio	-	$N = \omega_M / \omega_{L\max}$	
f	Angular Velocity for Response Frequency	Hz	$\omega_{L\max} = \theta_{L\max} (2\pi f_{\max})$	Where: $f_{\max} = (2\pi)^{-1} (\alpha_{L\max} / \theta_{L\max})^{0.5}$
α_L	Angular Acceleration for Response Frequency	Rad / sec ²	$\alpha_{L\max} = \theta_{L\max} (2\pi f_{\max})^2 = \omega_{L\max} (2\pi f_{\max})$	
f_n	Natural Circular Resonant Frequency	Hz	$f_n = (2\pi)^{-1} * [K_G (J_L + J_m N^2) / (J_L * J_m N^2)]^{0.5}$	
T_{LG}	Torques Referred to Load (Gimbaled Applications)	Oz-In or Nm	$T_{L\max} = (J_L \alpha_L + J_m N^2 (\alpha_L + \alpha_v) + B_L (\omega_L + \omega_v) + K_L (\theta_L + \theta_v) + F_c + Mg_L) \max$	

Where:

J_L = Load Inertia in Oz-In-s² or kgm²

J_m = Motor Inertia in Oz-In-s² or kgm²

ω_L = Load Angular Velocity

α_v = Vehicle Angular Acceleration

ω_v = Vehicle Angular Velocity

θ_v = Vehicle Angular Rotation

B_L = Viscous Friction at the Load

K_L = Spring Constant of Load

K_G = Gearhead Spring Constant

ω_M = Motor Velocity

F_c = Coulomb Friction Torque

θ_L = Angular Rotation at Load

Linear Conversion Equations

Symbol	Description	Units	Equation	
P_o	Mechanical Power Output Imperial	Watts	$P_o = (F_L * V_L) * (0.113)$	F_L in Lbs, V_L in in/sec
P_o	Mechanical Power Output System International	Watts	$P_o = (F_L * V_L)$	F_L in N, V_L in m/sec
J_{LRO}	Inertia of the load, reflected to the rotary output	Lb-in-sec ² or kgm ²	$J_{LRO} = (W_L/g) * (2\pi P)^{-2}$	Where: W_L = Weight of load in Lbs or N g = gravity acceleration constant (386 in/s ² or 9.8 m/s ²)
V_L	Velocity of Linear Output	in/sec or mm/sec	$V_L = \omega_{RO} / (P * 60)$	
ω_{RO}	Velocity at the Rotary Output	RPM	$\omega_{RO} = 60 * V_L * P$	
F_L	Force at Load	Lbs or N	$F_L = T_{RO} * (2\pi P \eta_{bs})$	
T_{RO}	Torque at the Rotary Output	Lb-In or Nm	$T_{RO} = F_L / (2\pi P \eta_{bs})$	

Where:

P = Pitch of Ball Screw (Revs/inch or Revs/m) - Note the Pitch = 1/Lead

η_{bs} = Ball Screw Efficiency (Typically 0.95)

Note - Be careful not to mix units!

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	Symbol	Data	Units	Parameter	Symbol	Data
Supply Voltage	V_s			Ambient Temperature Range	t	
Closed Loop Rotary Actuator						
Load Inertia	J_L			Acceleration at Load	α_L	
Max Load Velocity	ω_L			Load Coulomb Friction	F_{CL}	
Load Viscous Losses	B_{VL}			Mass Unbalance at max. g	M_{gj}	
Load Angular Rotation	θ_L			Bull Gear Ratio	N_B	-
Options:						
Acceleration Feedback	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Friction Brake	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Velocity Feedback	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Brake Torque Magnitude			
Load Position Feedback	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Motor Redundancy	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Open Loop Rotary Actuator						
Output Torque	T_L			Output Velocity	ω_L	
Duty Cycle	-					
Options:						
Friction Brake	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Brake Torque Magnitude			
Motor Redundancy	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Detent Brake	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Closed Loop Linear Actuator						
Load Weight	W_L			Acceleration at Load	α_L	
Max Load Velocity	ω_L			Load Coulomb Friction	F_{CL}	
Load Viscous Losses	B_{VL}			Stroke Length	θ_L	
Options:						
Acceleration Feedback	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Friction Brake	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Velocity Feedback	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Brake Torque Magnitude			
Load Position Feedback	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Motor Redundancy	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Open Loop Linear Actuator						
Output Torque	T_L			Output Velocity	ω_L	
Duty Cycle	-			Stroke Length	θ_L	
Options:						
Friction Brake	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Brake Torque Magnitude			
Motor Redundancy	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Detent Brake	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

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 engineering reference data brochures.



CDA INTERCORP

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