KOFORD
ENGINEERING, LLC

5.07 inch (129mm) Series

• Short axial length, high performance slotted or slotless housed or frameless brushless motors for Industrial, military, aerospace, and medical applications.

• 10 pole high power slotted designs for highest power, Low cog versions are slotted but have no measurable cog and sinusodial back emf, 20 pole slotted design is suitable for low speed applications and the higher pole count doubles the hall feedback resolution.

• Up to 95% efficiency

• Up to 1,523 watts continuous power.

• High temperature Class H 180°C insulation

• Available with hall sensors, or sensorless. Temperature sensors and thermal protection available.

• Long life premium synthetic bearing lube with -73C to 149C temperature range

• Encoders available

• Perfect sinusoidal back emf for ripple free torque at low speed when using sine wave drives with the low cog version. Ideal for direct drive applications.

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KOFORD ENGINEERING, LLC

5.07" (129mm) 10 pole, 48 volt Slotted Brushless motor

• 2,076 to 5,760 rpm no load **•Rated power up to 1,040 watts**

10 tooth slotted motor using class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or in sensorless configuration. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

Winding		43	96	120
Nominal supply voltage	volts	48	48	48
No load speed	rpm±12%	2,076	4,608	5,760
Speed/torque slope	rpm/oz-in	.81	1.9	2.2
Peak efficiency	%	93	93	92
Continuous stall torque heat sink/no hs.	oz-in*	1,128/777	803/527	630/413
Continuous torque heat sink/no h.s.	oz-in*	1,076/699	681/352	476/0
Motor constant Km	oz-in/√w	89	61	53
Winding resistance#	ohm±15%	.124	.053	.044
Peak output	watts	922	1,854	2,502
No load current	amp±50%	.45	1.28	1.87
Damping factor	oz-in/krpm	3.3	2.4	2.4
Static friction	oz-in	7.1	7.1	7.1
Velocity constant	rpm/volt±12%	43.3	96	120
Torque constant Kt	oz-in/amp	31.2	14.1	11.2
Winding inductance	mH	1.2	.21	.13
Mechanical time constant	ms	1.2	2.5	3.3
Rotor inertia	10^{-4}oz-in-sec^2	672	672	672
Thermal res. winding to housing	°C/W	.44	.32	32
Thermal res. housing to ambient	°C/W	1.12	1.12	1.12

Ambient temperature range -73C to 149C

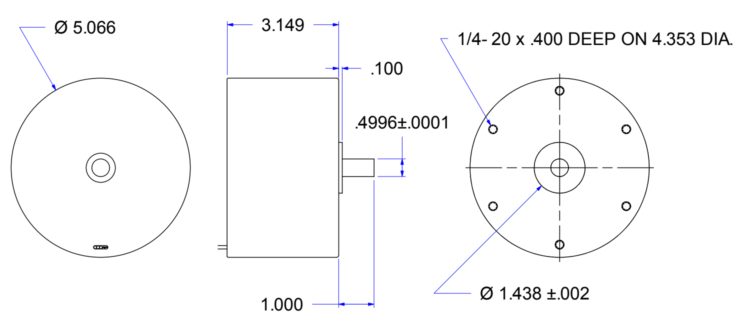
Weight 8lb. 12 oz., maximum winding temp. 180C Data is for winding and magnet temperature of 20°C

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is maximum running torque at nominal supply voltage and 130C winding temperature rise above 20C ambient.

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 43 A / A20

Motor type — 129

Type S=sensorless H=120°halls — H

Winding number — 43

Modifications A=none, T=thermistor, P=thermal protection — A

Encoder w index A20=2000line(8,000 count) — A20

Test Data
Total System Performance
129H43A Motor with H48V40A Controller at 48 Volts

Rpm	Torque Oz-in	Watts Out	Efficiency %	Amps
2018	0	0	0.0	0.5
1946	69	98	89.2	2.3
1873	137	190	87.4	4.5
1784	231	304	84.3	7.5
1697	325	406	81.9	10.3
1610	410	487	78.1	13.0
1524	496	557	74.4	15.6
1459	562	604	71.4	17.6
1394	628	646	68.4	19.7
1328	710	695	65.7	22.1
1263	785	731	62.3	24.4
1213	857	767	59.1	27.00
1163	935	802	56.8	29.4
1123	1013	839	54.4	32.1
1078	1091	867	51.5	35.1
1041	1169	897	49.4	37.8
1003	1247	922	47.2	40.7

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129S96A Motor with S48V40A Controller at 48 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
4818	0.00	0.00	0.0	1.36
4796	7.97	28.18	29.4	2.00
4747	35.41	124.38	64.8	4.00
4679	63.57	220.14	76.4	6.00
4610	91.70	312.80	81.5	8.00
4543	120.27	404.38	84.2	10.00
4475	148.77	492.74	85.5	12.00
4414	178.72	584.30	87.0	14.00
4352	209.12	673.52	87.7	16.00
4288	237.92	758.59	87.8	18.00
4225	269.44	842.54	87.8	20.00
4169	299.04	923.09	87.4	22.00
4119	328.80	1002.80	87.0	24.00
4051	361.92	1085.31	87.0	26.00
3964	394.75	1169.28	87.0	28.00
3916	427.09	1252.80	87.0	30.00
3860	467.81	1336.40	87.0	32.00
3810	501.28	1413.50	86.6	34.00
3772	534.78	1492.83	86.4	36.00
3736	570.19	1576.37	86.4	38.00
3686	603.84	1647.04	85.8	40.00

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129S120A Motor with S48V40A Controller at 48 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
5776	0.00	0.00	0.0	1.98
5744	3.63	15.42	11.9	2.70
5702	18.45	77.82	40.5	4.00
5643	43.62	169.63	58.9	6.00
5588	66.98	264.59	68.9	8.00
5521	92.98	359.50	74.9	10.00
5465	115.85	448.34	77.8	12.00
5411	140.47	541.57	80.6	14.00
5359	164.15	630.02	82.0	16.00
5303	189.50	721.97	83.6	18.00
5250	215.51	814.08	84.8	20.00
5200	239.30	898.19	85.1	22.00
5145	264.82	985.54	85.6	24.00
5093	285.63	1072.38	85.9	26.00
5034	310.70	1155.26	86.0	28.00
4996	338.99	1248.51	86.7	30.00
4948	361.43	1331.97	86.7	32.00
4921	384.83	1418.86	86.9	34.00
4868	410.43	1501.92	86.9	36.00
4809	435.64	1584.64	86.9	38.00
4773	460.76	1667.36	86.8	40.00

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

KOFORD ENGINEERING, LLC

5.07" (129mm) 10 pole, 24 volt Slotted Brushless motor.

• 1,040 to 2,866 rpm no load **•Rated power up to 585 watts**

10 tooth slotted motor designed for high speed blowers and pumps and servo applications. The windings use class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or sensorless versions are available. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

Winding		42	95	119
Nominal supply voltage	volts	24	24	24
No load speed	rpm±12%	1,040	2,280	2,866
Speed/torque slope	rpm/oz-in	.42	1.04	1.20
Maximum efficiency	%	92	91	91
Continuous stall torque heat sink/no hs.	oz-in*	1,128/777	720/473	625/417
Continuous torque heat sink/no h.s.	oz-in*	1,109/749	680/408	592/338
Motor constant Km	oz-in/√w	89	61	53
Winding resistance#	ohm±15%	.124	.053	.044
Peak output	watts	473	963	1,126
No load current	amp±50%	.34	.95	1.3
Damping factor	oz-in/krpm	3.3	2.7	2.7
Static friction	oz-in	7.1	7.1	7.1
Velocity constant	rpm/volt±12%	43	95	119
Torque constant Kt	oz-in/amp	31.2	14.1	11.2
Winding inductance	mH	1.2	.21	.13
Mechanical time constant	ms	1.2	2.5	3.3
Rotor inertia	10^{-4}oz-in-sec^2	672	672	672
Thermal res. winding to housing	°C/W	.44	.32	.30
Thermal res. housing to ambient	°C/W	1.12	1.12	1.12

Ambient temperature range -73C to 149C

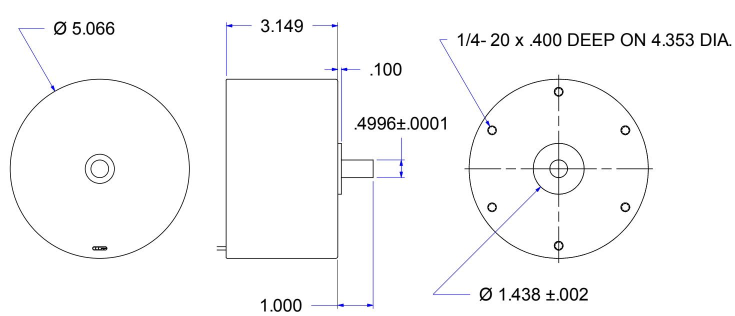
Weight 7lb. 3 oz., maximum winding temp. 180C Data is for winding and magnet temperature of 20°C

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is running torque at nominal supply voltage at 150°C winding temperature. Peak output shown limited by drive current rating.

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 42 A / A20

Motor type (129)

Type S=sensorless H=120°halls (H)

Winding number (42)

Modifications A=none, T=thermistor, P=thermal protection (A)

Encoder w index A20=2000line(8,000 count) (A20)

Test Data
Total System Performance
129H42A Motor with H24V40A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
996	0.00	0.00	0.0	0.33
958	56.27	39.87	83.1	2.00
920	125.95	85.76	89.3	4.00
882	200.80	131.01	91.0	6.00
847	275.68	172.98	90.1	8.00
814	355.20	214.11	89.2	10.00
784	433.92	251.81	87.4	12.00
756	511.68	286.42	85.2	14.00
730	587.36	317.47	82.7	16.00
705	663.04	346.08	80.1	18.00
682	732.64	370.06	77.1	20.00
660	795.20	388.22	73.5	22.00
639	853.28	403.70	70.1	24.00
616	907.16	418.55	67.1	26.00
594	958.35	432.48	64.4	28.00
571	1007.51	444.61	61.8	30.00
549	1055.61	456.21	59.4	32.00

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H95A Motor with H24V60A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
2412	0.00	0.00	0.0	0.94
2373	12.77	22.42	46.7	2.00
2330	40.96	70.64	73.6	4.00
2288	68.62	116.22	80.7	6.00
2247	97.46	162.08	84.4	8.00
2208	126.66	207.01	86.3	10.00
2171	155.52	249.87	87.5	11.90
2130	186.08	293.39	87.3	14.00
2095	216.40	335.60	87.4	16.00
2058	247.47	376.96	87.3	18.00
2024	276.78	414.59	86.8	19.90
1991	300.78	441.68	86.4	21.30
1958	330.19	478.29	85.9	23.20
1925	360.34	515.29	85.2	25.20
1891	405.23	567.14	84.4	28.00
1859	438.00	602.59	83.7	30.00
1816	477.55	641.92	82.8	32.30
1805	505.90	673.20	82.5	34.00
1776	532.66	700.02	81.7	35.70
1756	565.87	734.00	80.6	37.90
1719	601.42	765.00	79.7	40.00
1699	634.43	797.58	79.1	42.00
1669	665.71	822.43	77.9	44.00
1649	697.09	850.85	77.1	46.00
1621	728.99	874.42	75.9	48.00
1598	762.45	901.52	75.1	50.00
1578	788.38	920.75	73.8	52.00
1552	824.21	946.64	73.0	54.00
1526	853.82	963.97	71.7	56.00

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H119A Motor with H24V60A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
2872	0.00	0.00	0.0	1.44
2866	2.53	5.38	11.2	2.00
2823	25.95	54.24	56.5	4.00
2786	48.46	99.92	69.4	6.00
2748	72.26	146.93	76.5	8.00
2709	95.74	191.98	80.0	10.00
2675	119.06	235.73	81.9	12.00
2653	143.44	280.10	83.4	14.00
2624	167.62	323.01	84.1	16.00
2589	192.78	366.58	84.9	18.00
2559	217.42	408.37	85.1	20.00
2531	243.70	450.91	85.4	22.00
2502	267.70	489.78	85.0	24.00
2468	293.92	530.40	85.0	26.00
2439	320.94	572.13	85.1	28.00
2403	346.59	610.00	84.7	30.00
2373	372.19	648.35	84.4	32.00
2345	397.79	686.70	84.2	34.00
2320	422.28	722.11	83.6	36.00
2295	447.82	758.38	83.2	38.00
2264	473.16	791.33	82.4	40.00
2230	498.04	826.56	82.0	42.00
2194	528.46	858.13	81.3	44.00
2165	555.02	891.18	80.7	46.00
2135	581.04	918.22	79.7	48.00
2103	607.55	945.68	78.8	50.00
2073	632.90	970.85	77.8	52.00
2049	658.98	1001.79	77.3	54.00
2014	684.13	1030.85	76.7	56.00
1982	705.77	1058.56	76.0	58.00
1950	731.64	1084.64	75.3	60.00

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

KOFORD ENGINEERING, LLC

5.07" (129mm) 10 pole, 96 and 160 volt, slotted High Power Brushless motor.

• 1,040 to 4,157 rpm no load **•Rated power up to 1523 watts**

High power series. 10 tooth slotted motor for maximum power. The windings use class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or sensorless versions are available. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

Winding		44	30	23	31	45
Nominal supply voltage	volts	96	96	160	160	160
No load speed	rpm±12%	4,157	2,840	3,614	4960	6,620
Speed/torque slope	rpm/oz-in	1.6	1.1	1.3	1.7	2.6
Maximum efficiency	%	94	93	94	94	95
Continuous stall torque heat sink/no hs.	oz-in*	1128/777	852/612	1128/777	852/ 612	1128/777
Continuous torque heat sink/no h.s.	oz-in*	968/516	775/497	1002/578	676/320	640/0
Motor constant Km	oz-in/√w	92	79	89	79	92
Winding resistance#	ohm±15%	.124	.334	.455	.334	.124
Peak output	watts	1991	1351	1731	2668	4579
No load current	amp±50%	.47	.32	.32	.41	.65
Damping factor	oz-in/krpm	2.0	2.6	3.3	2.34	2.1
Static friction	oz-in	7.1	7.1	7.1	7.1	7.1
Velocity constant	rpm/volt±12%	41.3	30	23	31	45
Torque constant Kt	oz-in/amp	32.6	45.6	63.8	45.6	32.6
Winding inductance	mH	1.19	2.55	3.99	2.55	1.19
Mechanical time constant	ms	1.2	1.5	1.2	1.5	1.2
Rotor inertia	10^{-4}oz-in-sec^2	672	672	672	672	672
Thermal res. winding to housing	°C/W	.44	.32	.44	.32	.44
Thermal res. housing to ambient	°C/W	1.12	1.12	1.12	1.12	1.12

Ambient temperature range -73C to 149C

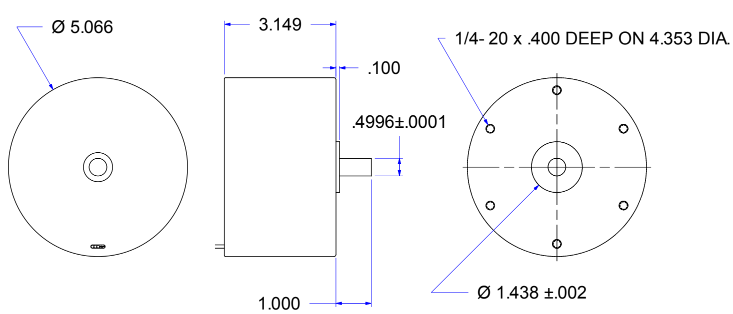
Weight 8lb. 12 oz., maximum winding temp. 180C Data is for winding and magnet temperature of 20°C

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is running torque at nominal supply voltage

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 43 A / A24

Encoder w index A20=2000line(8,000 count)

Motor type

Type S=sensorless H=120°halls

Winding number

Modifications A=none, T=thermistor, P=thermal protection

Test Data
Total System Performance
129H45T Motor with H160V10A Controller at 160 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
6620	0.00	0.00	0.0	0.68
6591	10.51	51.26	32.0	1.00
6479	44.22	212.03	66.3	2.00
6380	78.30	369.73	77.0	3.00
6277	114.45	531.63	83.1	4.00
6180	150.40	687.94	86.0	5.00
6077	188.32	847.57	88.3	6.00
5991	226.08	1003.01	89.6	7.00
5897	260.32	1136.27	89.2	7.96
5810	303.20	1303.98	90.2	9.04
5743	338.56	1439.26	90.6	9.93

Dyno test results of a motor and drive combination with voltage held to 160v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H31T Motor with H160V10A Controller at 160 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
4730	0.00	0.00	0.0	0.41
4651	27.28	93.89	58.7	1.00
4548	75.02	252.50	78.9	2.00
4442	126.67	416.48	85.6	3.04
4347	176.80	568.98	88.9	4.00
4253	228.64	719.89	89.8	5.01
4170	279.36	862.66	90.2	5.98
4083	337.76	1020.75	90.9	7.02
3998	395.36	1170.18	90.7	8.06
3924	449.44	1305.26	90.5	9.01
3846	506.88	1443.01	90.0	10.02

Dyno test results of a motor and drive combination with voltage held to 160v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H44T Motor with H160V10A Controller at 96 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
3970	0.00	0.00	0.0	0.51
3929	16.56	48.14	50.2	1.00
3869	50.78	145.44	75.4	2.01
3800	85.54	240.61	83.3	3.01
3741	121.23	335.66	87.2	4.01
3677	156.37	425.57	89.0	4.98
3621	194.56	521.47	90.4	6.01
3567	231.36	610.82	91.2	6.98
3509	273.12	709.20	91.9	8.04
3457	311.52	796.98	92.0	9.02
3406	351.68	886.83	92.2	10.02
3384	368.80	923.94	92.0	10.46

Dyno test results of a motor and drive combination with voltage held to 96v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H31T Motor with H160V10A Controller at 96 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
2840	0.00	0.00	0.0	0.32
2789	32.02	66.08	68.2	1.01
2721	80.14	161.36	84.0	2.00
2652	129.52	254.19	88.3	3.00
2589	180.96	346.94	90.1	4.01
2526	234.08	437.60	91.0	5.01
2473	285.28	522.22	90.8	5.99
2412	345.28	616.51	90.8	7.07
2362	398.08	695.90	90.3	8.03
2316	452.48	775.46	89.8	9.00
2265	511.04	856.75	88.9	10.04

Dyno test results of a motor and drive combination with voltage held to 96v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

KOFORD
ENGINEERING, LLC

5.07" (129mm) 10 pole, 48 volt Low Cog Brushless motor

• 2,520 to 8,352 rpm no load **•Rated power up to 963 watts**

10 tooth slotted motor designed with no measurable cog and sinusoidal back emf. The windings use class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with a stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or in sensorless configuration. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

Winding		52.5	71	103	169	174
Nominal supply voltage	volts	48	48	48	48	48
No load speed	rpm±12%	2,520	3,408	4,934	8,112	8,352
Speed/torque slope	rpm/oz-in	3.3	3.3	8.3	10.4	20
Peak efficiency	%	94	94	94	92	93
Continuous stall torque heat sink/no hs.	oz-in*	570/434	570/434	398/274	413/314	344/231
Continuous torque heat sink/no h.s.	oz-in*	557/416	556/403	375/245	378/226	184/150
Motor constant Km	oz-in/√w	54	54	38	35	30
Winding resistance#	ohm±15%	.234	.124	.126	.053	.066
Peak output	watts	395	635	445	967	735
No load current	amp±50%	.20	.32	.30	1.30	.67
Damping factor	oz-in/krpm	1.0	.99	.30	.95	.30
Static friction	oz-in	2.7	2.7	2.7	2.7	2.7
Velocity constant	rpm/volt±12%	53	71	102	169	174
Torque constant Kt	oz-in/amp	25.7	19.0	13.1	7.99	7.76
Winding inductance	mH	2.3	1.2	1.2	.21	.34
Mechanical time constant	ms	2.8	2.8	4.6	2.8	7.2
Rotor inertia	10^{-4}oz-in-sec^2	565	565	459	565	459
Thermal res. winding to housing	°C/W	.44	.44	.44	.44	.36
Thermal res. housing to ambient	°C/W	1.12	1.12	1.12	1.12	1.12

Ambient temperature range -73C to 149C

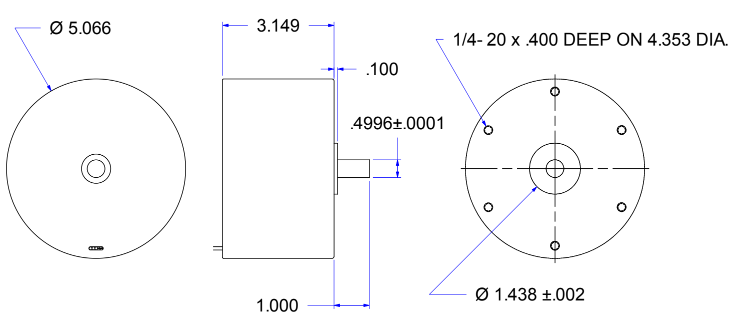
Weight 8lb. 12 oz., maximum winding temp. 180C Data is for winding and magnet temperature of 20°C

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is maximum running torque at nominal supply voltage

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 43 A / A20

Encoder w index A20=2000line(8,000 count)

Motor type

Type S=sensorless H=120°halls

Modifications A=none, T=thermistor, P=thermal protection

Winding number

KOFORD
ENGINEERING, LLC

5.07" (129mm) 10 pole, 48 volt Low Cog Brushless motor

• 10,416 rpm no load **•Rated power up to 719 watts**

10 tooth slotted motor designed with no measurable cog and sinusoidal back emf. The windings use class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with a stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or in sensorless configuration. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

Winding		210
Nominal supply voltage	volts	48
No load speed	rpm±12%	10,416
Speed/torque slope	rpm/oz-in	14.2
Peak efficiency	%	91.7
Continuous stall torque heat sink/no hs.	oz-in*	395/257
Continuous torque heat sink/no h.s.	oz-in*	320/ 109
Motor constant Km	oz-in/√w	30
Winding resistance#	ohm±15%	.044
Peak output	watts	395
No load current	amp±50%	1.92
Damping factor	oz-in/krpm	1.0
Static friction	oz-in	2.7
Velocity constant	rpm/volt±12%	210
Torque constant Kt	oz-in/amp	6.22
Winding inductance	mH	.13
Mechanical time constant	ms	9.1
Rotor inertia	10^{-4}oz-in-sec^2	565
Thermal res. winding to housing	°C/W	.30
Thermal res. housing to ambient	°C/W	1.12

Ambient temperature range -73C to 149C

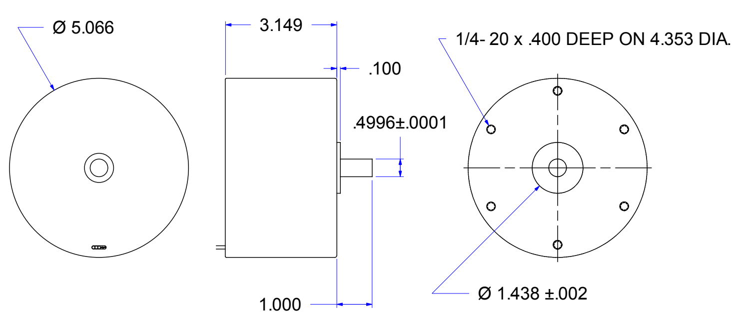
Weight 8lb. 12 oz., maximum winding temp. 180C Data is for winding and magnet temperature of 20°C

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is maximum running torque at nominal supply voltage

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 43 A / A20

Motor type — 129

Type S=sensorless H=120°halls — H

Winding number — 43

Modifications A=none, T=thermistor, P=thermal protection — A

Encoder w index A20=2000line(8,000 count) — A20

Test Data
Total System Performance
129H174T Motor with H48V40A Controller at 48 Volts

Rpm	Torque Oz-in	Watts Out	Efficiency %	Amps
9084	0.00	0.00	0.0	0.70
8681	12.64	80.64	70.0	2.40
8198	28.16	170.72	79.0	4.50
7700	50.00	284.00	84.0	7.04
7117	76.16	400.16	87.8	9.50
6400	110.00	522.00	88.0	12.35
5767	142.88	609.76	85.8	14.80
5000	190.00	685.00	81.0	17.60
4206	237.05	735.21	74.7	20.50
3359	285.28	708.96	61.0	24.20

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H169T Motor with S48V40A Controller at 48 volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
8128	0.00	0.00	0.0	1.33
7805	20.98	121.20	63.1	4.00
7583	38.59	216.54	75.2	6.00
7366	56.61	308.61	80.4	8.00
7153	76.05	402.56	83.9	10.00
6954	95.34	490.72	85.2	12.00
6777	115.01	576.85	85.8	14.00
6709	134.46	663.36	86.4	16.00
6510	152.69	735.63	85.1	18.00
6360	173.55	816.83	85.1	20.00
6064	198.82	896.31	84.9	22.00

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H103T Motor with H48V40A Controller at 48 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
4934	0.00	0.00	0.0	0.35
4528	24.32	81.44	84.8	2.00
4110	56.16	170.72	89.0	4.00
3688	95.36	260.48	90.4	6.00
3276	140.00	339.36	88.4	8.00
2354	216.64	377.44	78.6	10.00
1883	282.56	393.92	68.4	12.00
1669	329.44	407.20	60.6	14.00
1555	362.40	417.12	54.3	16.00
1479	388.48	425.22	49.2	18.00
1426	411.04	433.89	45.2	20.00
1385	429.28	440.08	41.7	22.00

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/ or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H71T Motor with H48V40A Controller at 48 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
3418	0.00	0.00	0.0	0.35
3228	33.79	80.74	84.1	2.00
3012	77.87	173.60	90.4	4.00
2808	127.17	264.26	91.8	6.00
2617	180.16	348.90	90.9	8.00
2421	239.68	429.57	89.5	10.00
2238	301.28	499.18	86.7	12.00
1935	383.20	548.85	81.7	14.00
1680	457.44	568.72	74.1	16.00
1550	510.56	585.92	67.8	18.00
1470	551.04	599.41	62.4	20.00
1408	588.00	612.78	57.5	22.20
1371	613.12	622.02	53.8	24.10

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/ or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H210T Motor with H48V40A Controller at 48 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
10416	0.00	0.00	0.0	1.94
10074	14.21	105.94	50.2	4.40
9900	25.01	183.18	63.6	6.00
9669	38.77	277.47	72.3	8.00
9428	53.94	376.34	77.6	10.10
9275	67.65	464.27	79.9	12.10
9222	80.43	549.01	81.7	14.00
9093	94.70	637.33	83.0	16.00
8969	108.42	719.70	82.8	18.10
8704	123.70	796.75	82.6	20.10
8600	135.07	859.70	81.4	22.00

Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

KOFORD
ENGINEERING, LLC

5.07" (129mm) 10 pole, 24 volt Low Cog Brushless motor.

• 1,265 to 4,152 rpm no load **•Rated power up to 481 watts**

10 tooth slotted motor designed with no measurable cog and sinusoidal back emf using class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or in sensorless configuration. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

Winding		52	70	102	169	173
Nominal supply voltage	volts	24	24	24	24	24
No load speed	rpm±12%	1,265	1,680	2,436	4,056	4,152
Speed/torque slope	rpm/oz-in	2.9	1.6	4.3	5.2	10.6
Maximum efficiency	%	91	93	92	92	93
Continuous stall torque heat sink/no hs.	oz-in*	570/434	570/434	398/274	413/314	344/194
Continuous torque heat sink/no h.s.	oz-in*	557/416	556/410	376/246	379/227	322/230
Motor constant Km	oz-in/√w	54	54	38	35	30
Winding resistance#	ohm±15%	.234	.124	.126	.053	.066
Peak output	watts	182	330	240	588	445
No load current	amp±50%	.16	.24	.32	.79	.51
Damping factor	oz-in/krpm	1.2	1.1	.3	.89	.3
Static friction	oz-in	2.7	2.7	2.7	2.7	2.7
Velocity constant	rpm/volt±12%	52	70	102	169	173
Torque constant Kt	oz-in/amp	25.6	19.3	13.3	7.99	7.72
Winding inductance	mH	2.3	1.2	1.2	.21	.34
Mechanical time constant	ms	4.6	4.6	4.6	2.8	7.2
Rotor inertia	10^{-4}oz-in-sec^2	459	565	459	565	459
Thermal res. winding to housing	°C/W	.44	.44	.44	.44	.36
Thermal res. housing to ambient	°C/W	1.12	1.12	1.12	1.12	1.12

Ambient temperature range -73C to 149C

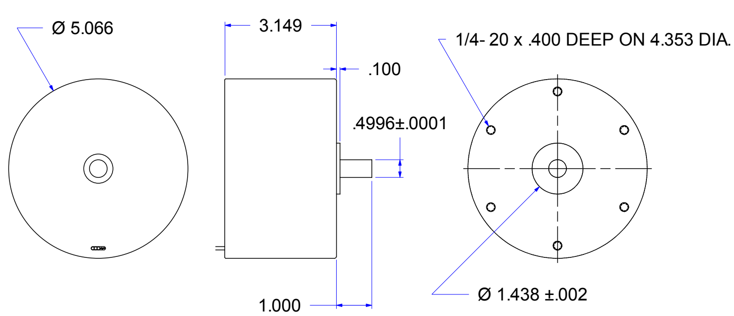
Weight 7lb. 3 oz., maximum winding temp. 180C   Data is for winding and magnet temperature of 20°C

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is running torque at nominal supply voltage at 150°C winding temperature.

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 102 A / A20

Motor type (129)

Type S=sensorless H=120°halls (H)

Winding number (102)

Modifications A=none, T=thermistor, P=thermal protection (A)

Encoder w index A20=2000line(8,000 count) (A20)

KOFORD ENGINEERING, LLC

5.07" (129mm) 10 pole, 24 volt Low Cog Brushless motor

• 5,232 rpm no load **•Rated power up to 482 watts**

10 tooth slotted motor designed with no measurable cog and sinusoidal back emf. The windings use class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with a stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or in sensorless configuration. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

Winding		210
Nominal supply voltage	volts	24
No load speed	rpm±12%	5,232
Speed/torque slope	rpm/oz-in	8.0
Peak efficiency	%	90.3
Continuous stall torque heat sink/no hs.	oz-in*	395/257
Continuous torque heat sink/no h.s.	oz-in*	371/218
Motor constant Km	oz-in/√w	54
Winding resistance#	ohm±15%	.044
Peak output	watts	685
No load current	amp±50%	1.31
Damping factor	oz-in/krpm	1.0
Static friction	oz-in	2.7
Velocity constant	rpm/volt±12%	210
Torque constant Kt	oz-in/amp	6.22
Winding inductance	mH	.13
Mechanical time constant	ms	9.1
Rotor inertia	10^{-4}oz-in-sec^2	565
Thermal res. winding to housing	°C/W	.30
Thermal res. housing to ambient	°C/W	1.12

Ambient temperature range -73C to 149C

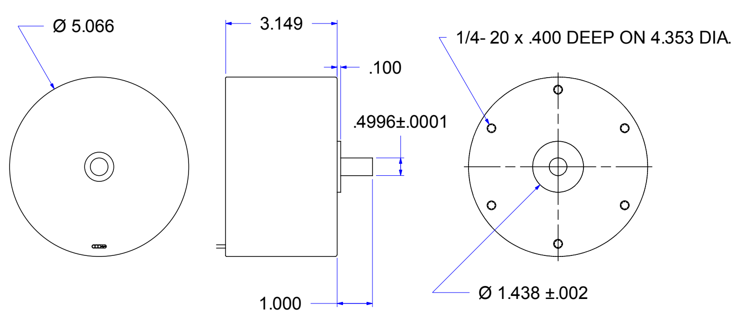
Weight 8lb. 12 oz., maximum winding temp. 180C Data is for winding and magnet temperature of 20°C

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is maximum running torque at nominal supply voltage

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 43 A / A20

Motor type (129)

Type S=sensorless H=120°halls (H)

Winding number (43)

Modifications A=none, T=thermistor, P=thermal protection (A)

Encoder w index A20=2000line(8,000 count) (A20)

Test Data
Total System Performance
129H169T Motor with H24V40A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
4092	0.00	0.00	0.0	0.82
4015	8.32	24.70	51.5	2.00
3892	24.75	71.28	74.3	4.00
3766	42.08	117.26	81.4	6.00
3649	59.78	161.44	84.1	8.00
3535	78.56	205.57	85.7	10.00
3423	98.24	247.97	86.1	12.00
3314	118.29	289.07	86.0	14.00
3212	138.04	326.95	85.1	16.00
3129	158.08	364.74	84.4	18.00
3043	177.49	398.27	83.0	20.00
2962	198.29	433.10	82.0	22.00
2865	221.02	466.94	81.1	24.00
2781	242.57	497.44	79.7	26.00
2713	264.96	530.07	78.9	28.00

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H102T Motor with H24V20A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
2472	0.00	0.00	0.0	0.28
2247	24.96	41.60	86.7	2.00
2025	57.28	85.78	89.4	4.00
1816	94.72	127.36	88.4	6.00
1620	136.32	163.52	85.1	8.00
1438	180.80	192.64	81.0	9.90
1186	235.68	206.88	71.8	12.00
1015	284.64	213.92	63.7	14.00
909	326.72	219.76	57.2	16.00
846	358.40	224.37	51.9	18.00

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H70T Motor with H24V40A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
1710	0.00	0.00	0.0	0.27
1603	35.55	42.19	87.9	2.00
1490	78.22	86.29	89.9	4.00
1375	128.35	130.64	90.7	6.00
1275	179.52	169.46	88.3	8.00
1176	235.68	205.10	85.5	10.00
1084	293.28	235.34	81.7	12.00
1002	351.52	260.59	77.6	14.00
927	408.80	280.61	73.1	16.00
861	463.04	295.18	68.3	18.00
798	513.60	303.41	63.2	20.00
755	549.76	310.00	58.7	22.00
730	588.64	317.90	55.2	24.00
706	618.08	322.91	51.7	26.00

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/ or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H173T Motor with H24V20A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
4542	0.00	0.00	0.0	0.55
4424	7.68	25.12	69.8	1.50
3995	36.16	106.88	89.1	5.00
3700	60.00	162.00	89.0	7.60
3458	81.92	209.12	88.0	9.90
3200	110.00	260.00	86.2	12.60
2954	137.92	301.60	83.8	15.00
2670	170.00	333.00	79.0	17.60
2432	197.60	355.68	74.8	19.80

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/ or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

Test Data
Total System Performance
129H210T Motor with H24V40A Controller at 24 Volts

Rpm	Torque oz-in	Watts Out	Efficiency %	Amps
5232	0.00	0.00	0.0	1.33
5119	8.11	30.72	47.4	2.70
5034	16.67	62.11	64.7	4.00
4909	30.00	108.96	75.7	6.00
4785	44.11	156.18	81.3	8.00
4658	58.14	200.40	83.5	10.00
4549	72.45	243.90	84.7	12.00
4429	87.60	287.15	85.5	14.00
4316	102.78	328.35	85.5	16.00
4201	119.17	370.50	85.8	18.00
4099	134.98	409.44	85.3	20.00
4028	149.66	446.16	84.5	22.00
3883	168.02	482.85	83.8	24.00

Dyno test results of a motor and drive combination with voltage held to 24v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Losses include drive, motor, and motor leads. Efficiency can be improved by shortening motor leads

KOFORD ENGINEERING, LLC 5.07" (129mm) 20 pole Brushless motor.

• 1,336 to 5,334 rpm no load **•Rated power up to 600 watts**

20 tooth slotted motor for 50% less cog then high power 10 tooth version. Excellent for lower speed applications. Higher pole count provies higher resolution when halls are used for speed/positon feedback. The windings use class H 180°C insulation for ruggedness. 200°C Neo magnets are used along with stainless shaft, and high temp TFE insulated lead wires. Unit are supplied either with 120° halls rated at 150°C, or sensor-less versions are available. Thermal protection and temperature sensors are available. Custom windings, encoders and gearboxes are available.

Motor Data

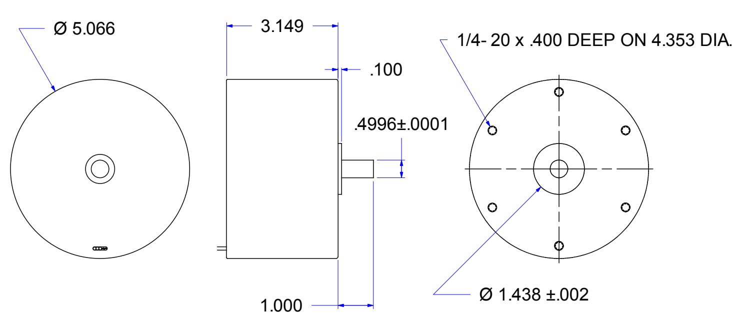
Winding		55	56	27	57	13
Nominal supply voltage	volts	24	48	48	96	160
No load speed	rpm±12%	1,336	2,667	1,280	5,334	2,136
Speed/torque slope	rpm/oz-in	1.7	3.3	1.6	6.5	2.6
Maximum efficiency	%	93	94	93	95	94
Continuous stall torque heat sink/no hs.	oz-in*	879/605	879/605	879/605	879/605	879/605
Continuous torque heat sink/no h.s.	oz-in*	867/588	847/558	868/589	777/445	853/569
Motor constant Km	oz-in/√w	69	69	69	69	69
Winding resistance#	ohm±15%	.124	.124	.538	.124	2.15
Peak output	watts	193	396	185	807	317
No load current	amp±50%	.26	.36	.12	.55	.08
Damping factor	oz-in/krpm	1.8	1.8	1.8	1.8	1.8
Static friction	oz-in	3.9	3.9	3.9	3.9	3.9
Velocity constant	rpm/volt±12%	55.6	55.6	26.7	55.6	13.3
Torque constant Kt	oz-in/amp	24.3	24.3	50.6	24.3	101
Stall current	amps	193.5	387	89	774	74
Winding inductance	mH	1.19	1.19	5.16	1.19	20.8
Mechanical time constant	ms	1.5	1.5	1.5	1.5	1.5
Rotor inertia	10^{-4}oz-in-sec^2	672	672	672	672	672
Thermal res. winding to housing	°C/W	.44	.44	.44	.44	.44
Thermal res. housing to ambient	°C/W	1.12	1.12	1.12	1.12	1.12
Ambient temperature range -73C to 149C						
Weight 8lb. 12 oz., maximum winding temp. 180C Data is for winding and magnet temperature of 20°C						

*0.3°C/W heat sink or sufficient airflow over motor for equal thermal resistance/still air and no heat sink. Continuous torque is running torque at nominal supply voltage

#Lead wires resistance 4.7mΩ if used at full length

Leads are 12" minimum

Phase leads are 14 gauge, hall leads are 28 gauge, all TFE



Leads	
Blue	Phase A
White	Phase B
Brown	Phase C
Red	+5 volts
Black	Ground
Yellow	Sensor A
Orange	Sensor B
Green	Sensor C

Ordering Information: Please send your order to: mail@koford.com

Example: Part Number 129 H 56 A / A24

Motor type — 129

Type S=sensorless H=120°halls — H

Winding number — 56

Modifications A=none, T=thermistor, P=thermal protection — A

Encoder w index A20=2000line(8,000 count) — A24

KOFORD
ENGINEERING, LLC

5.07" (129mm) Frameless Slotted Brushless motor.

The frameless configuration can be used for direct drive applications where the motor is integrated into the product and the rotor is directly mounted onto the spindle or shaft of the product. This can reduce size and increase rigidity of the product.

The rotor can be attached to the customers shaft by axial clamping or with a suitable epoxy. Press fitting should not be used.

Mounting of the stator using heat shrinking is recommended as this will will provide good heat transfer. For heat shrinking usually an aluminum housing would be used. If this is not practical then axial clamping can be used.

The housing for the motor should be designed so that there is as much gap as possible between the magnet and the metal of the housing. This will reduce eddy current losses at higher rpm.

If epoxy is used then the minimum bondline of the epoxy must be considered as some materials contain large particle fillers. The recommended adhesive for room temperature cure is 3M DP460 (don’t use static mixer and dispense a large enough quantitiy of material that the correct amount from both components is dispensed) The stator and rotor may be mounted using heat cured epoxy. Koford E-110 is recommended for heat cure.

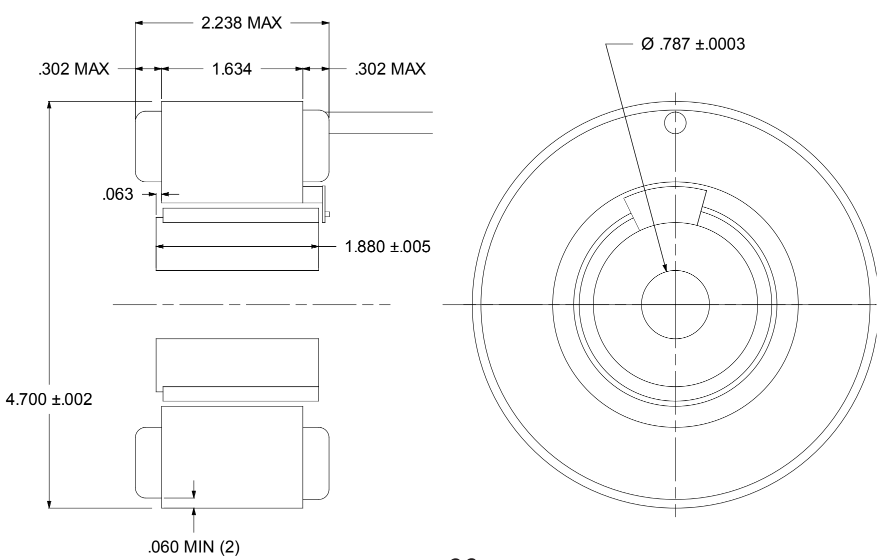
The weight of the frameless motor is 7lb.

The part number for a frameless motor is the same as a housed motor except that F follows the 129. For example:

housed motor: 129H43T

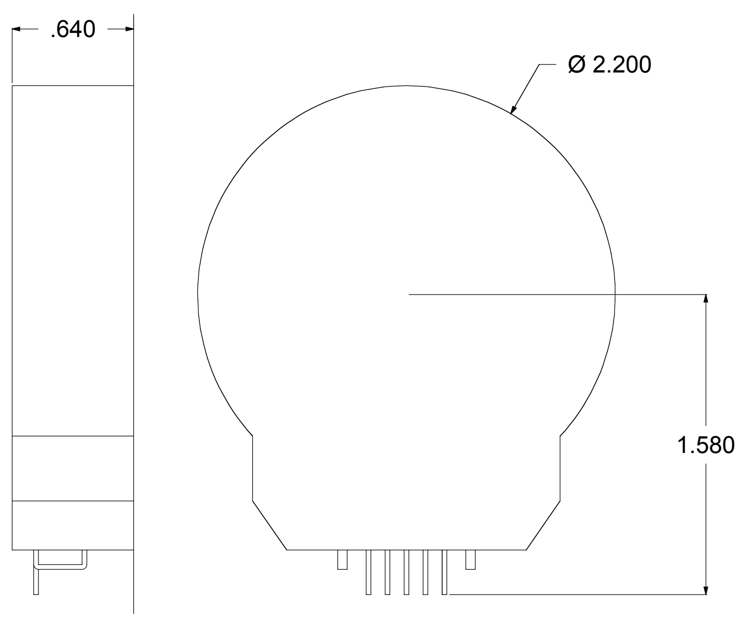
frameless version: 129FH43T

Encoders are not available on a frameless motor. The cross section of a hall sensor frameless motor is shown below, the sensorless version is the same except without the hall board.



Optical Encoder

Mating connector AMP 103977-4. Supply voltage is 5±.5V. Rpm 9,000 max.



Thermistor resistance for Koford motors

Temp [degree C]	Temp [degree F]	Rt/R25	Temp Coef [%/C]	Resistance [ohm]
-50	-58	66.970	7.10	334850
-45	-49	47.250	6.86	236250
-40	-40	33.740	6.62	168700
-35	-31	24.370	6.40	121850
-30	-22	17.800	6.19	89000
-25	-13	13.130	5.99	65650
-20	-4	9.776	5.80	48880
-15	5	7.347	5.63	36735
-10	14	5.570	5.46	27850
-5	23	4.257	5.30	21285
0	32	3.279	5.10	16395
5	41	2.550	4.95	12750
10	50	1.998	4.81	9990
15	59	1.576	4.68	7880
20	68	1.252	4.55	6260
25	77	1.000	4.43	5000
30	86	0.804	4.31	4019
35	95	0.650	4.20	3249
40	104	0.528	4.09	2641
45	113	0.432	3.99	2158
50	122	0.355	3.74	1773
55	131	0.295	3.63	1474
60	140	0.247	3.54	1233
65	149	0.207	3.44	1035
70	158	0.175	3.35	874
75	167	0.148	3.26	741
80	176	0.126	3.18	631
85	185	0.108	3.10	539
90	194	0.092	3.03	462
95	203	0.080	2.95	398
100	212	0.069	2.86	344
105	221	0.060	2.78	299
110	230	0.052	2.70	261
115	239	0.046	2.63	228
120	248	0.040	2.56	200
125	257	0.035	2.50	177
130	266	0.031	2.44	156
135	275	0.028	2.37	138
140	284	0.025	2.31	123
145	293	0.022	2.26	110
150	302	0.020	2.20	98

Unit conversions

°F -32 ÷1.8=°C example: 212°F=100°C, °C x1.8+32=°F example: 100°C=212°F, in x 25.40=mm, mm x.03937= in., oz x 28.3495=g, oz-in x 7.06=mNm, mNm x .142=oz-in, Nm x 142=oz-in, rpm x .1047=rad s^{-1}, V/R/S x .1047=volts/rpm, 746 watts=1hp, lb-in^2 x .04144=oz-in-sec^2

Understanding Data Sheets

When comparing Koford motors to data sheets for other motors be careful to note the conditions associated with the rated torque listed. For example many manufactures list continuous torque at stall or at rpm less then the maximum. Usually this is because these motors will overheat if run continuously at full speed even with no load.

Hall Sensors

Like other semiconductor components hall sensors are electrostatic sensititive. Hall motors are supplied in electrostatic safe packaging and should be kept in the packaging until use. When trimming wire length, adding connectors, and hooking up motors, workers should be grounded to prevent electrostatic damage to the sensors.

Motor technology

The Koford 119mm brushless series of motors are slotted sintered rare earth permanent magnet motors with advanced technology. Up to 95% efficiency 180C insulation, a fully machined one part anodized aluminum housing, hardened stainless shaft, TFE sealed bearings, -73C-149C operating temperature range, and TFE insulated lead wires are some of the features. These are slotted motors and the high power versions have moderate cog, the low cog versions have almost undetectable cog but the power output however they are are more suitable for high speed applications.

Motor selection

Motors for continuous duty applications such as pumps, blowers etc. should in most cases be selected to operate at rated continuous torque without heat sinking. If the ambient is elevated then this value should be reduced. Keep in mind that the drive used has a great effect on motor operating temperature. The lowest motor temperature rise will occur with the drive pwm duty cycle at 100% (maximum speed). Using a higher speed winding then necessary and reducing the speed through the drive will result in higher motor and drive operating temperatures then if a winding is selected that will run as close as possible to full speed. During variable speed operation, when the motor is operating at less then full speed, both the motor and drive operating temperature will be influenced by the drive frequency. Drive pwm frequencies of 18kHz or higher are recommended for best performance. For the highest performance Koford drives are recommended. Unlike many drives Koford drives can operate up to 100% duty cycle transfering the full power supply or battery voltage to the motor. Sine output drives greatly reduce motor output and efficiency and testing should be done before using them.

For variable speed applications where the motor does not operate continuously, the safest approach is to specify the motor with the continuous operating torque equal to the maximum load. If the maximum load is not known then the continuous motor current rating should be more then the current limit of the drive. This will prevent the possibility of overload. For example if the current rating of the drive is 5 amps, the motor Kt is 3.0 and the no load current is 1.0 amps, continuous torque rating should be more then (5-1.0) x 3.0=12 oz-in. If the duty cycle is known then the equivalent continuous torque can be estimated. Keep in mind that the resistance losses are a function of the current squared so reducing the duty cycle to fifty percent will only allow the torque to be increased by 41% not 100%.

When comparing Koford motors to data sheets for other motors be careful to note the conditions associated with the rated torque listed. For example many manufactures list continuous torque at stall or at a rpm below full speed. This value cannot be obtained when the motor is running at operating speed.

Selection of Hall, or Sensorless Configuration

The most common motor configuration is the hall sensor design. For positioning applications either hall must used or encoders or resolvers which will provide the drive with commutation information must be used. For fans pumps or similar applications sensorless motors can be used.

Speed torque calculations

A motors no load speed is equal to the supply voltage times the velocity constant (rpm/v). Under load the rpm will drop. To determine the approximate speed, use dyno data if listed, or use the speed torque slope from the data sheet. For example if the supply voltage is 28 volts and the rpm/volt is 500 then the no load speed will be 14,000 rpm. If the speed torque slope is 800 rpm/oz-in and a 5 oz-in load is applied to the shaft then the speed will be 14,000-(5 x 800) = 10,000 rpm. If there is extra wiring between the drive and the motor, or the supply and the drive, then the speed will drop at a more rapid rate due to the voltage drop in the wiring. A design margin of at least 15% should be used to allow for motor tolerances, so for example with the above motor the rpm can be expected to be at least 8,500 rpm.

Motor cooling

The continuous output torque which can be achieved from a motor is limited by the allowable maximum temperature. This in turn is determined by the cooling provided by the user, and the ambient temperature. In the case of some high speed motors the continuous output torque is shown as zero if the motor does not have heat sinking. In these cases the motor can only be used in intermittent duty applications unless appropriate heatsinking is used. If the ambient temperature is above 20°C then the continuous duty torque is reduced. Many motors are available with temperature sensors and this can be useful during prototyping to evaluate cooling. The actual limitation is the rotor (magnet) temperature, but since the windings surround the rotor, the temperature can be assumed to be the same in most cases. One exception is in pump applications (frameless or housed) where the interior of the motor is filled with refrigerant or water/glycol. In these applications the rotor temperature can be expected to closely follow the fluid temperature. For applications in air the allowable output torque can be increased by mounting the motor to a thick aluminum plate with surface area several times larger then the surface area of the motor. Further improvements can be obtained with the use of a fan directed at the body of the motor. Even higher performance can be obtained by the use of a refrigerant cooled sleeve around the outside diameter of the motor coupled with heatsink grease. If the motor housing can be cooled below 20°C then improved performance above data sheet values can be obtained. If only natural convection is used and the motor is mounted to plastic or a low thermal conductivity material such as steel then consideration should be given to ensuring free flow of air over the motor. Placing the motor in a small enclosed space with poor thermal connection to the outside ambient can result in considerable reduction in the amount of output power possible without overheating. When performing temperature rise calculations remember that the resistance of the copper windings increases with temperature. You must use the resistance at the operating temperature not at 20C. For example at 150°C the winding resistance is 1.51 times the resistance at 20°C, so this higer value must be used when calculating copper losses.

Frameless motors

Frameless motors are useful for certain specialized applications where housed motors cannot be used. These include air bearing or magnetic bearing motors, and pump applications where the rotor and impeller are part of a single assembly with the working fluid inside of the motor. All Koford motors can withstand continuous exposure to refrigerants. Frameless motors should be avoided for any application where a housed motor can be used. The 119mm motor is not suitable for use in water, however water glycol mistures with corrosion inhibitors may be possible. In many cases sleeve bearings are used with water instead of ball bearings so as to prevent corrosion and the possibilities of particles from jamming the ball bearings.

Vacuum Applications

All Koford motors are suitable for low vacuum applications. For high vacuum applications (option V) contact the factory. Vacuum grade motors are made with low outgassing material and baked before shipping. A vacuum bake by the customer immediately prior to use may be desirable to reduce pump down time. An important consideration is that in a vacuum there is no heat removal by air contacting the motor housing. Therefore the mounting of the motor should be made of highly thermally conductive material, such as copper or aluminum, should be of as heavy a cross section as possible, and should connect to a large surface exposed to the outside air.

Motor hook up

Phase and sensor wires should be routed separately and away from other wires to reduce electrical interference. The leads should be cut as short as possible to reduce EMI and power losses. Where electrical noise is a consideration the phase wires may be twisted or braided with each other or enclosed in a shielded jacket. The same can be done with the hall leads to prevent their picking up EMI from noise sources.

EMI

Koford drives and motors have low levels of emi relative to other motors but in sensitive applications the following steps are suggested. For conducted emissions add a common mode inductor. For radiated emissions place the drive and motor in a metal box, if that is not possible place the drive in a metal box. The drive and motor should be as close together as possible, avoid extending the wire lengths. Some improvement can be obtained by twisting the phase wires together and then twisting the hall wires together and if possible keeping the hall wires separated from the phase wires as much as possible. Shielding of the wires can also be used. If it is possible to vary the voltage to the drive insteading of using the speed pot that will also reduce emi.

Sine Drives

Sine drives are useful for very accurate motion around zero speed. At higher speeds e.g. above 3,000 rpm there in not any noticable difference in noise/vibration/velocity accuracy with sine drives. The use of Sine drives results in lower power output and reduced efficiency compared to standard drives (block commutation) when compared with the same motor.

Permanent Magnet Synchronous motors, DC Brushless motors, AC Permanent Magnet motors

These are all different names for the same type of motor.

System efficiency

The system efficiency is different then the motor efficiency. The system efficiency takes into account motor losses, drive losses, wiring losses, and gearbox losses. The choice of a drive will make a large difference in the total system efficiency. The data sheet value for maximum motor efficiency is with the drive set to maximum speed. At less then 100% speed efficiency will be reduced. For example if a motor is operated at 12 volts with the speed control turned all of the way up, the efficiency will be better then if the motor is operated with 24 volts into the drive and the speed set at 50%. Although the motor speed is the same, there are additional losses in the drive and motor to drop the 24 volts down to 12 volts. The amount of these losses is determined by the drive and motor design. Higher frequency drives will slightly increase overall efficiency.

PWM basics

Variable speed drives operate using PWM where the voltage to the motor is rapidly turned on and off. This is the same as a switching power supply where the motor is the filter. A PWM drive operates like a transformer, for example if the motor pulls 20 amps at 12 volts and the input to the drive is 36 volts then the input current to the drive will be 12/36 x 20 or 6.66 amps (neglecting losses). A drive rated at 20 amps will only pull 20 amps from the power supply or battery if the speed is turned all of the way up (no PWM).