

# Hollow shaft motor/encoders

## CM-4000 series, 4" brushless DC hollow shaft servo motor/encoder

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### Description:

The CM-4000 is a high performance 2" ID hollow shaft brushless DC motor with integral optical encoder characterized by a very high torque to inertia ratio.

The motor was specifically designed for high resolution positioning applications without sacrificing speed. For different motor characteristics, please contact the factory.

The following encoder configurations are available:

- ultra low distortion incremental sine/cosine specifically designed for use with interpolators, yielding up to 144 million measuring steps
- digital incremental up to 36,000 c/r (144,000 measuring steps)
- digital incremental with built-in interpolation (-HHC version) from 50,000 c/r (200,000 measuring steps) to 2,250,000 c/r (9 million measuring steps)
- 18/20 bit absolute in parallel format (external electronics necessary)

Typical applications include semiconductor wafer processing equipment, turret scanners and in general 'direct drive' applications where a gearbox is unsuitable or not economical.

### Mechanical Data:

hollow shaft ID:	2.000" ± 0.0003" through hole
shaft loading:	40 lbs axial, 35 lbs radial
shaft runout:	.0002" T.I.R.
starting torque:	4.5 oz.in max @20°C
shaft rotation:	continuous, reversible
shaft speed:	3,600 RPM max (mechanical)
shaft material:	stainless steel
housing material:	aluminum (stainless optional)
bearing life:	manufacturer's specs
moment of inertia:	0.04 oz.in.sec <sup>2</sup>
weight:	approx. 4 lbs
temperature:	operating: -20°C to+90°C
shock:	50 G's @ 11 ms
vibration:	5-2,000 Hz @ 20 G's
humidity:	98% without condensation
protection class:	IP 40

### Ordering information:

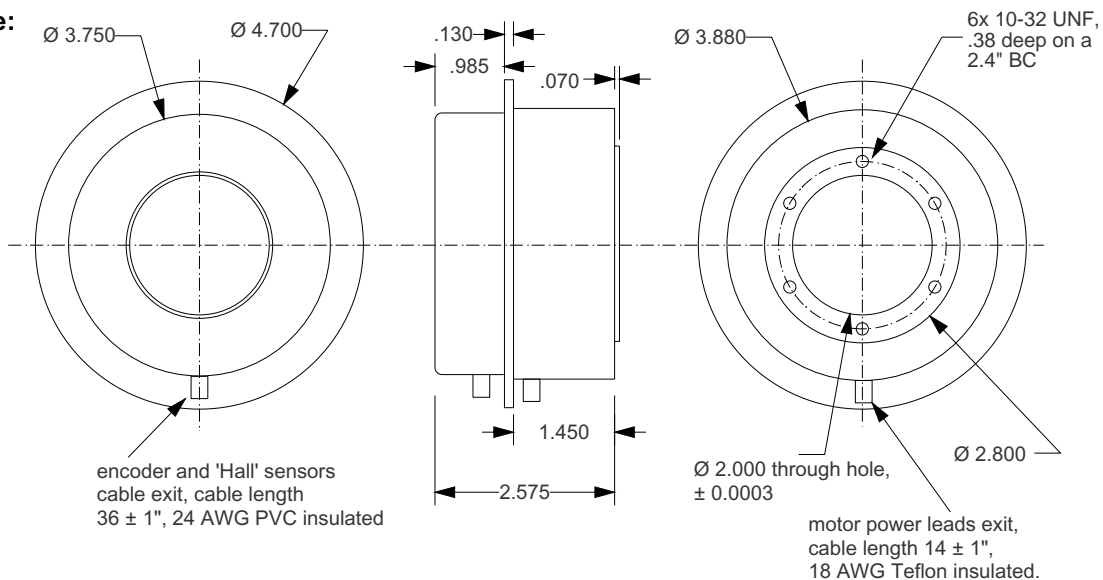
CM-4000-(linecount): sine/cosine output encoder.  
standard linecounts: 2,000 c/r, 9,000 c/r

CM-4050-(linecount): digital output encoder.  
standard linecounts: 2,000, 4,000, 9,000, 18,000 & 36,000 c/r

CM-4050-HHC-(linecount): digital output with integral interpolator: 50,000, 62,500, 100,000, 125,000, 200,000, 225,000, 250,000, 281,000, 400,000, 450,000, 500,000, 562,500, 900,000, 1,125,000, 1,800,000 & 2,250,000 c/r.

For absolute output, please consult factory.

### Outline:



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### Motor specifications

#### size constants @ 25°C ambient:

parameter	symbol	unit	value
maximum rated torque @ temperature rise of 80°C	Tr	in-oz	720
		Nm	5.1
maximum continuous stall torque @ temperature rise of 80°C	Tc	in-oz	163
		Nm	1,15
motor constant	Km	in-oz/√W	25.6
		Nm/√W	0.18
electrical time constant	Te	ms	.68
mechanical time constant	Tm	ms	7.2
angular acceleration (theoretical)		rad/sec <sup>2</sup>	21582
thermal resistance*	TPR	°C/Watt	1.9
maximum cogging torque	Tf	in-oz	2.9
		Nm	0.02
viscous damping	Fi	in-oz/rpm	0.0027
		Nm/rpm	1.9E-05
hysteresis drag torque	Th	in-oz	1.7
		Nm	0.012
number of poles		P	16

(\*) TPR assumes motor mounted to an aluminum heatsink of 12.1" x 12.1" x 0.50 in still air @ 20°C.

#### winding constants @ 25°C ambient\*:

design voltage	Vp	Volt	48.0
peak torque, ± 25%	Tp	in-oz	720
		Nm	5.1
peak current, ±15%	Ip	Ampere	44.5
torque sensitivity, ±10%	Kt	in-oz/A	16.2
		Nm/A	0.11
no-load speed	Snl	rpm	3880
		rad/s	406
voltage constant	Kb	V/krpm	12
		V/rad/s	0.11
terminal resistance, ± 12%	Rm	Ohm	0.4
terminal inductance, ±30%	Lm	mH	0.27

#### motor performance @ 48.0V:

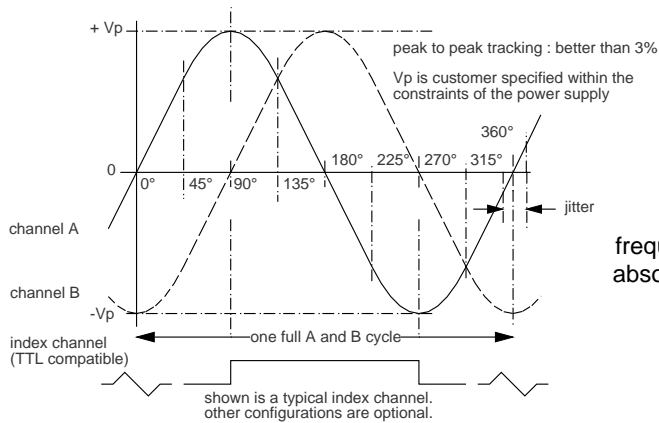
Continuous power output @ -temperature rise of 80.1°C, -still air cooling -ambient temperature of 25°C	power	Watt	249
		horsepower	0.33
	torque	in-oz	103
		Nm	0.73
	speed	rpm	3250
	phase current	Ampere	8
	I (DC link)	Ampere	6.4
	efficiency	%	81

(\*) other configurations available

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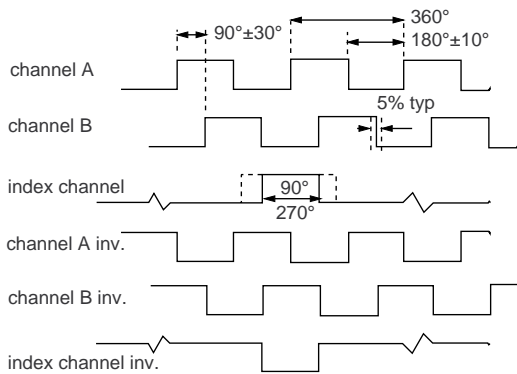
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## Encoder specifications



### sine/cosine:

- power supply:  $\pm 5$  Vdc @ 60 mA max.
- code: incremental, sine/cosine
- output format: A and B channel in quadrature, index
- output: default  $V_{out} = \pm 0.5$  V , zero-centered flat up to 100 kHz
- frequency response: flat up to 100 kHz
- absolute accuracy of zero-crossings:  $\pm 12$  arcseconds typ.
- distortion: less than 5% (Rmax/Rmin)

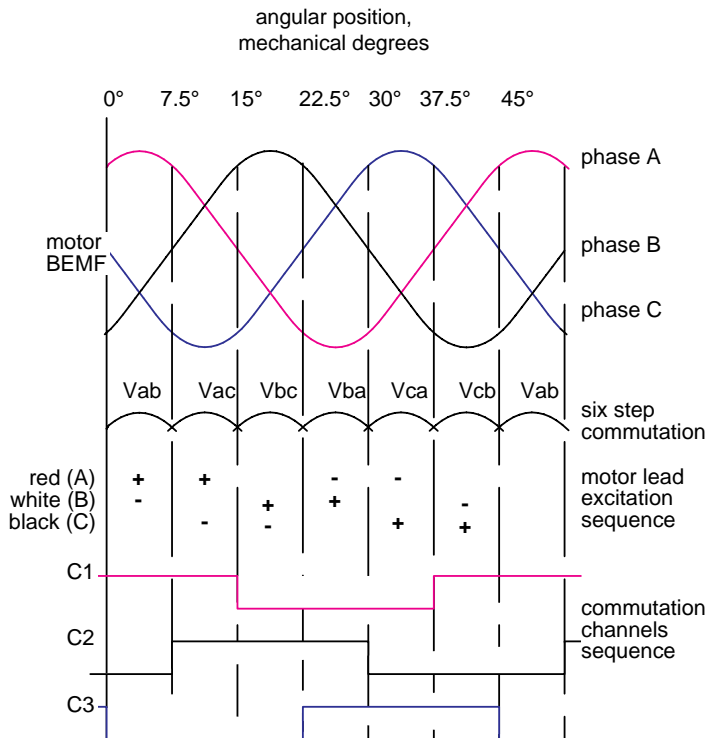


### digital, incremental:

- power supply: + 5Vdc  $\pm 10\%$  @ 100 mA max (no load)
- output format: incremental, digital
- frequency response: 150 kHz min. @ 85 °C
- interpolated: 3.5 MHz min. @ 85°C
- linedriver output: 26LS31, EIA std. RS 422 & DIN 66259 compatible
- absolute accuracy of zero-crossings:  $\pm 12$  arcseconds typ.

digital, absolute: 18 & 20 bits

## Motor excitation sequence and "Hall" switch output



### Motor wire color code:

- red phase A
- white phase B
- black phase C

### "Hall" switch color code:

- brown C1
- orange C2
- yellow C3
- blue + 5V to + 24V
- green ground