MS23C

Size 23 Stepper Motor

Description:

The **MS23C** is an industry standard NEMA size 23 stepper motor featuring high torque and all metal construction. The **MS23C** is optimized for microstepping and offers 1.8° per full step with 200 full steps per revolution. The stepper motor is manufactured especially for US Digital by NMB Technologies, a well-established industry leader in the designing and manufacturing of precision stepper motors and ball bearings.

The standard **MS23C** is a 4-wire connector interface that has already been configured for Bipolar Parallel operation. The **MS23C** comes with a 12" long cable / connector assembly (custom cable lengths are available). The **MS23C** configuration is ideal for use with our **MD2S** microstepping motor driver and is highly recommended. When driving in Bipolar Series, Bipolar Half Coil or Unipolar modes the **MS23** is available with 8-wire leads.

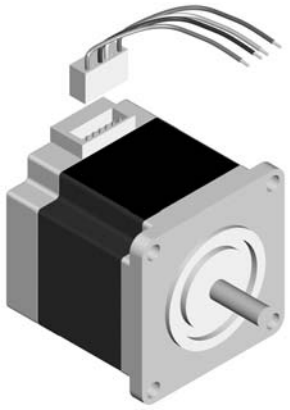
The **MS23C** stepper motor may be ordered from stock with or without a pre-attached US Digital kit encoder. Compatible kit encoders include the **E5D**, **E5S**, **E6D** and **E6S**. US Digital will mount these encoders at no extra cost and combined pricing is available on the fifth page of this data sheet.

This product is part of US Digital's **Motion Control Building Block**. To learn more, please see the corresponding section on the fifth page of this data sheet.

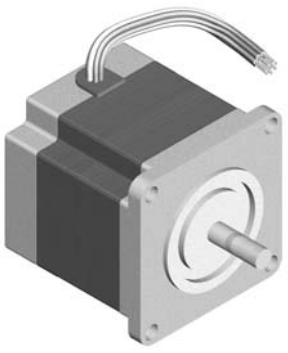
The stepper motor has a 0.250" diameter shaft on the front and rear. The shaft endplay has been limited to 0.010" for excellent encoder performance and minimum vibration.

Features:

- Industry standard size 23 stepping motor
- Two phase, 1.8° step angle, 200 full steps per rev.
- High angle accuracy
- Optimized for micro-stepping applications
- 8-wire motor lead or 4-pin connector for maximum versatility
- 110 oz-in running torque
- High quality NMB ball bearings
- Minimal endplay
- All metal construction
- Double-ended shaft construction
- Encoder ready, available with or without US Digital encoder attached
- US Digital warrants its products against defects and workmanship for two years. See complete warranty for details.

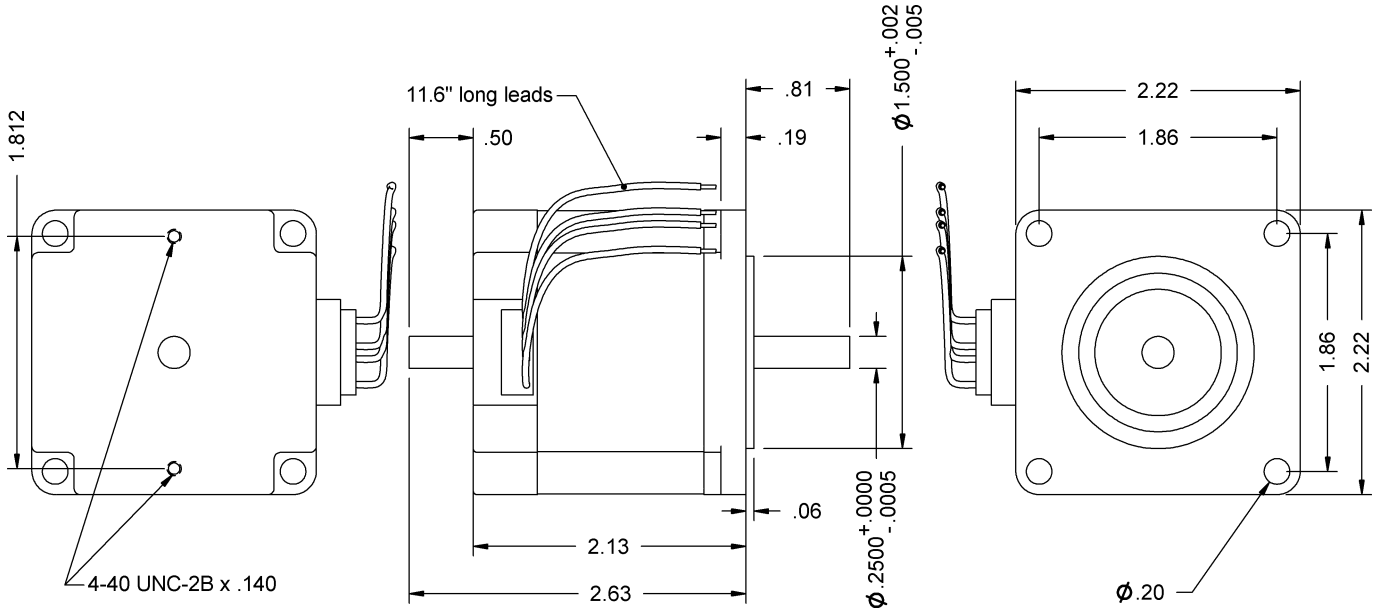


MS23C (standard)
4-wire connector



MS23
8-wire leads

Mechanical Drawing (Shown with MS23C):



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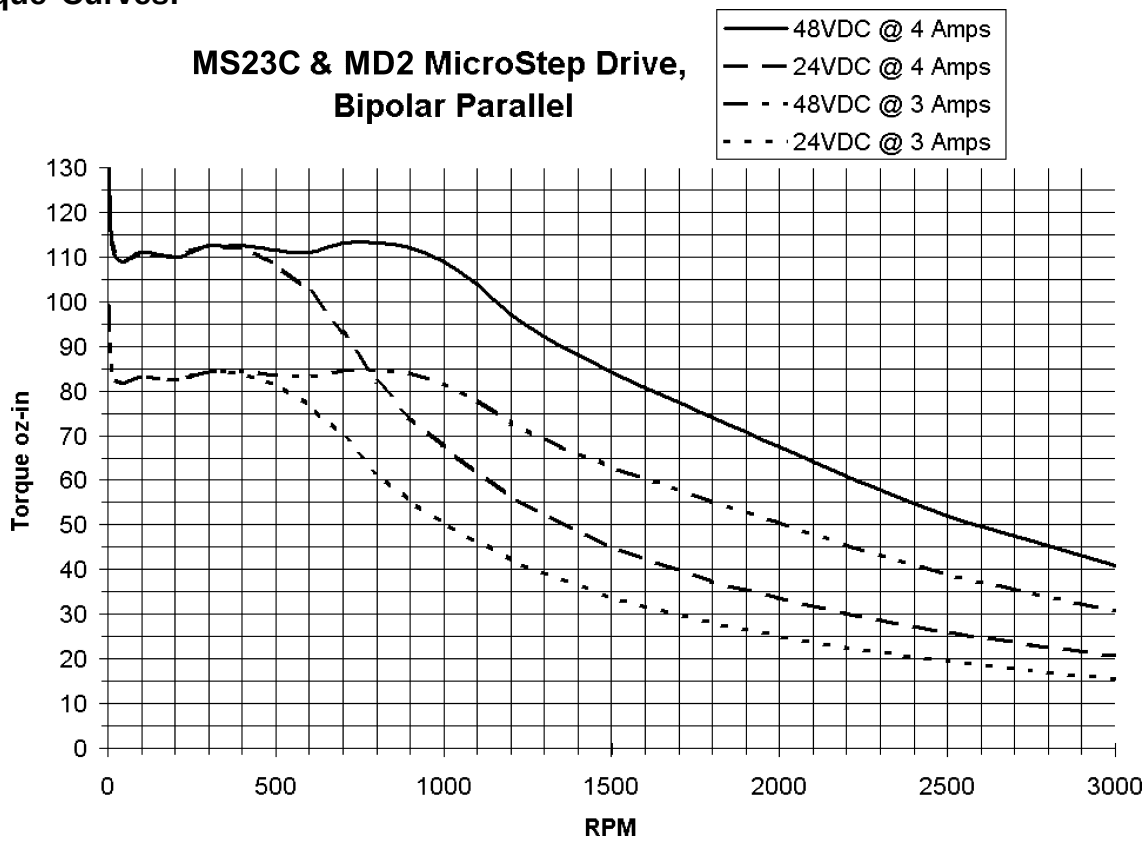
Speed-Torque Curves:



Terms & Definitions:

Wiring Configuration:
Bipolar Parallel Mode: Both coils of phase A are connected in parallel, likewise for phase-B. The inductance seen by the external motor driver is one fourth that of Bipolar Series Mode. This mode provides the highest speed performance for the lowest power supply voltage.

Bipolar Series Mode: Both coils of phase A are connected in series, likewise for phase-B. The inductance seen by the external motor driver is four times greater than that of Bipolar Parallel Mode. This mode allows the motor to be driven with a lower current for lower speed applications.

Stepping:
Full Stepping: The process of switching the motor current from -100% to +100% (two increments) in a four step quadrature sequence. Each step (quadrature state) moves the rotor 1.8 degrees (one full step). This type of driver is simple and low cost, and produces maximum vibration and noise.

Half Stepping: The process of switching the motor current in three levels from -100% to 0 to +100% (three increments) in an eight step sequence. Each step moves the rotor 0.9 degrees (one half step). This type of driver is also relatively simple and produces medium vibration and noise.

Microstepping: The process of progressively metering the motor current from -100% to +100% in many small increments, moving the rotor from one pole position to the next in tiny steps (microsteps). The current waveform is similar to a sine wave. One full sine wave will move the rotor 1.8 degrees (one full step). This driver is currently the most popular and provides smooth, quiet movement with very fine control of rotor position. Typical micro-stepping drivers provide selectable resolutions from 1 to 256 microsteps per full step (200 to 51,200 micro-steps per motor revolution). For best microstepping performance, the shape of the internal motor poles are modified for smooth pole-to-pole transitions. This minimizes the natural detent force, linearizing the movement, and minimizing vibration. The **MS23C** has been optimized for microstepping.

Torque:
Detent Torque: The amount of torque required to rotate a stepper motor shaft without power applied to the windings.

Holding Torque: The amount of torque required to rotate the stepper motor shaft while the windings are energized with maximum DC current at zero speed.

Pull In Torque: The amount of torque a stepper motor can produce without losing synchronism starting from a zero speed state, then given a fixed frequency step sequence.

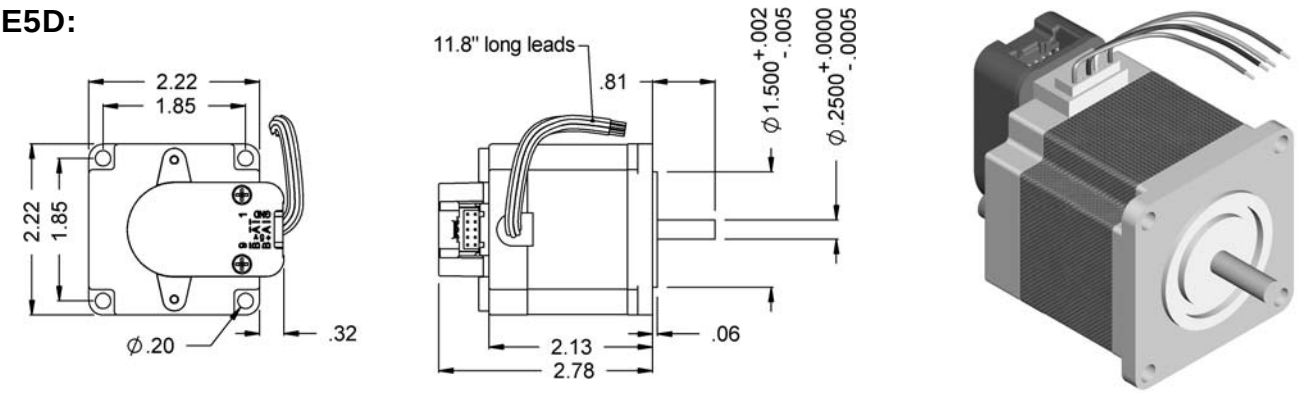
Pull Out Torque: The amount of torque a stepper motor can produce at a particular operating speed without losing synchronism.

Speed / Torque Limits:
Why does the torque decline as the speed increases, and what sets the maximum speed? Torque is directly proportional to the current flowing in the motor coils. The current must ramp up to +100%, then -100% 50 times per revolution (200 quadrature states). The coil inductance opposes changes in current. The current does not have enough time to ramp up to maximum at higher speeds. Before it reaches maximum, it must reverse and ramp the other direction. The maximum rate of current change is inversely proportional to the square of the inductance and directly proportional to the power supply voltage. Maximum speed with minimum torque loss is obtained by minimizing the coil inductance and maximizing the power supply voltage. Since bipolar parallel mode has one fourth the inductance, of bipolar series mode, the torque is much geater at higher speeds. The **MS23C** motors have been designed for minimum inductance.

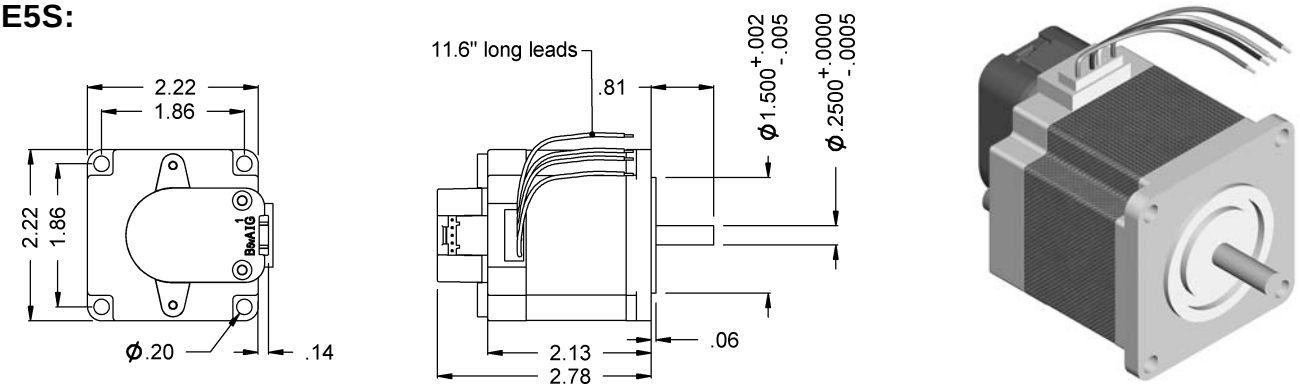
Mechanical Drawings (Encoder Version):

- The drawings below only show the **MS23C** (4-wire connector); the **MS23** (8-wire leads) *IS ALSO* available with an encoder attached.
- For encoder information see each encoder's data sheet.

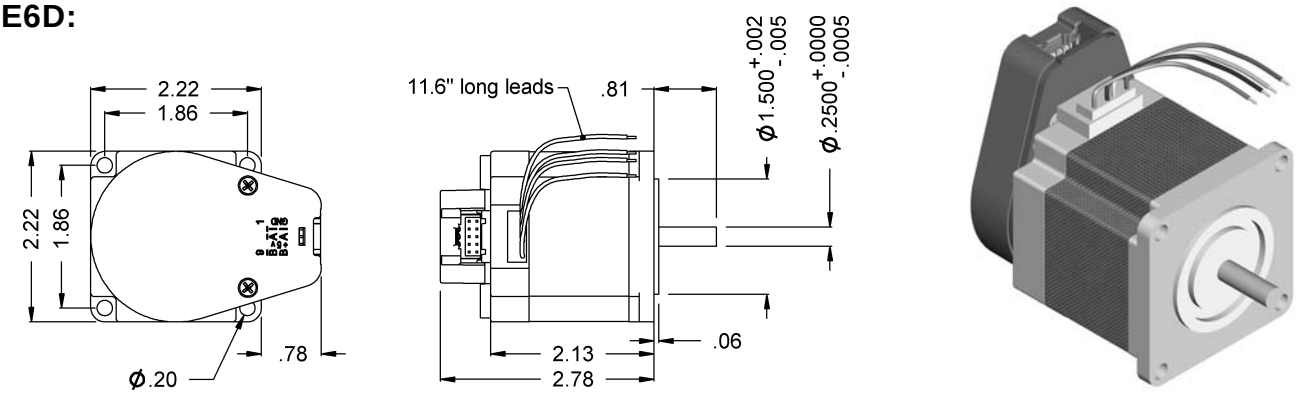
E5D:



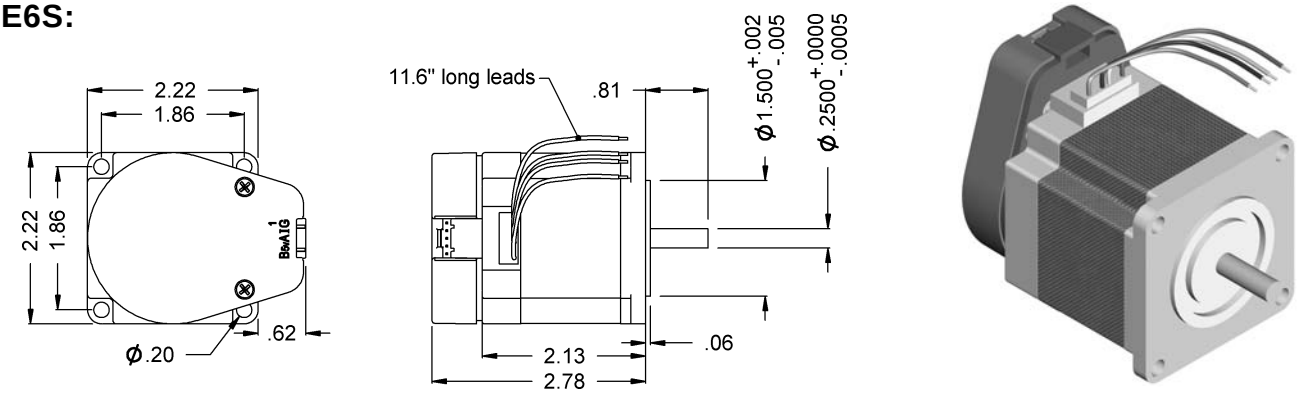
E5S:



E6D:



E6S:



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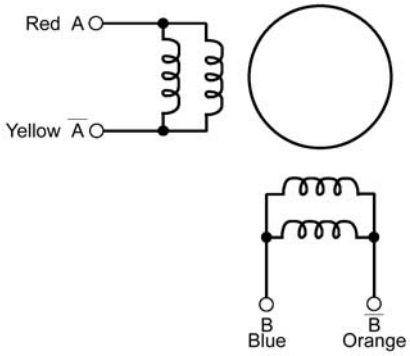
MS23C

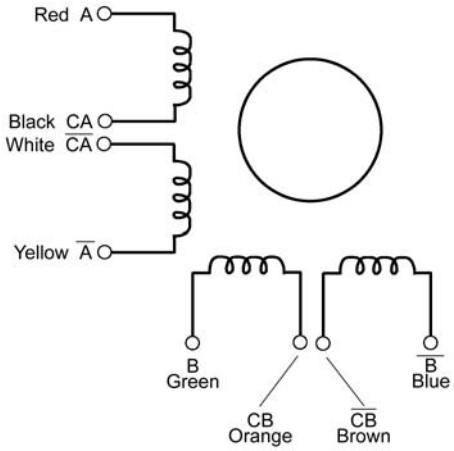
Size 23 Stepper Motor

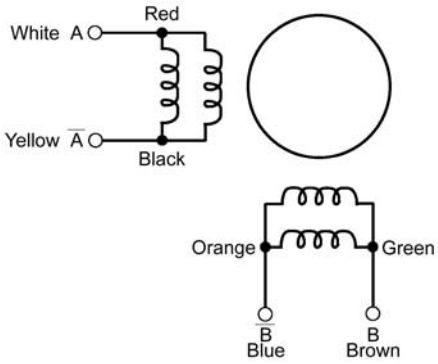
Motor Winding Diagrams:

MS23C (4-wire connector):



MS23 (8-wire leads):





MS23C Pin-out:

Pin	Description	Color
1	A channel	Red
2	NC	-
3	A- channel	Yellow
4	B channel	Blue
5	NC	-
6	B- channel	Orange

Switching Sequence:

Step	A	B	$\overline{A}$	$\overline{B}$
1	+	+	-	-
2	-	+	+	-
3	-	-	+	+
4	+	-	-	+

➢ For clockwise rotation facing motor output shaft.

Absolute Maximum Ratings:

Parameter	Max.	Units
Caes Temperature	130	℃
Ambient Temperature	50	℃
Motor Power Dissipation	7.65	Watts
Maximum Phase Current*	-	-

* See bipolar parallel specifications above.

Mechanical Specifications:

Parameter	Dimension	Units	Notes
Full Step Angle	1.8	degrees	
Step Angle Accuracy	±5	%	
Insulation Resistance	100	MOhm	Min.
	500	VDC	
Dielectric Strength	500	VAC	for 1 minute
Radial Play	0.0008	in.	Max. (1 lbs load)
End Play	0.010	in.	Max.
Detent Torque	4.9	oz-in	
Rotor Inertia	3.96×10^{-3}	oz-in-s^2	

Bipolar Parallel Specifications:

Parameter	Value	Units
Full Step Current	4.20	Amps
Micro Step Current	5.90	Amps
DC Resistance	0.43	Ohms
Inductance	1.73	mH
Power Per Phase	7.65	Watts
Power Total	15.3	Watts
Holding Torque (static torque)	140	oz-in
Running Torque	110	oz-in

Compatible Cables & Connectors:

MS23C:

Stepper Motor Connector:	
6-pin	**Description**
CA-6352-1FT	Connector on one end with 4 12" wires (two pins are left open)

➢ The above cable is included with the **MS23C** and does not need to be ordered separately.
➢ Custom cable lengths are available. See the **Cables & Connectors** data sheet for details.

Encoder Version:

Finger-latching Connector:		
5-pin	**10-pin**	**Description**
CON-FC5-22*	CON-FC10	Connector
CA-3133-1FT	-	Connector on one end with 4 12" wires
CA-3132-1FT	-	Connector on one end with 5 12" wires
CA-3131-6FT	CA-4217-6FT	Connector on one end with a 6' shielded round cable
-	CA-4174-6FT	Same as CA-4217-6FT, but for **L**-option only
CA-3620-6FT	CA-3619-6FT	Connectors on both ends of a 6' shielded round cable
-	CA-3807-6FT	Same as CA-3619-6FT, but for **L**-option only

* 22 AWG is standard. 24, 26 and 28 AWG are also available.

Attention:
➢ Specify cable length when ordering.
➢ Custom cable lengths are available. See the **Cables & Connectors** data sheet for details.

Encoder Version Pin-outs:

5-pin:

Pin	Description
1	Ground
2	Index
3	A channel
4	+5VDC power
5	B channel

10-pin Standard:

Pin	Description
1	Ground
2	Ground
3	Index-
4	Index+
5	A- channel
6	A+ channel
7	+5VDC power
8	+5VDC power
9	B- channel
10	B+ channel

10-pin Agilent:

Pin	Description
1	No connection
2	+5VDC power
3	Ground
4	No connection
5	A- channel
6	A+ channel
7	B- channel
8	B+ channel
9	Index-
10	Index+

MS23C — Size 23 Stepper Motor

Motion Control Building Block:

The **MS23C** may be combined with US Digital's **MD2S** microstepping motor driver and one of our switching power supplies to provide a motion control building block that simply requires step and direction input signals to set the **MS23C** stepper motor in motion. Alternatively, the quadrature outputs from an optical encoder may be connected to the step and direction inputs to control the motor position.

Switching Power Supplies:
For more detailed information on the power supplies, see either the **PS-24**, **PS-48, PS-150 and PS-320** data sheets.

Part Number: **PS-24** (24V, 2.5A)	**$25.20 / 1 • $19.64 / 100**
Part Number: **PS-48** (48V, 2.5A)	**$50.40 / 1 • $39.27 / 100**
Part Number: **PS-320-24** (24V, 12.5A)	**$177.45 / 1 • $145.95 / 100**
Part Number: **PS-320-48** (48V, 6.5A)	**$177.45 / 1 • $145.95 / 100**


PS-24


PS-48


PS-320

Microstepping Motor Driver:
US Digital offers a programmable microstepping motor driver that interfaces with size 17 through size 42 stepper motors. The **MD2S** is specially tuned to match US Digital's size 23 stepper motor and provide excellent Speed-Torque characteristics.

For more detailed information on the microstep drive, see the **MD2S** data sheet.

Part Number: **MD2S**	**$136.00 / 1 • $104.00 / 100**

Ordering Information:

Motor Only :
$62.00 / 1
$55.65 / 10
$50.40 / 50
$45.00 / 100
$40.95 / 500
$38.85 / 1K

Part #:

Motor only — Optical Encoder Version (optional)

MS23C — [ ] — [ ] — [ ]

Interface:
C = 12" 4-wire connector assembly.*
(**blank**) = 8-wire leads.

Optical Encoder:
E5D = Differential 1" encoder.
E5S = Single-ended 1" encoder.
E6D = Differential 2" encoder.
E6S = Single-ended 2" encoder.

CPR:

E5S / E5D		E6S / E6D
32***	500	64***
50	512	100
96	540**	200
100	720***	400
110**	900***	500
120**	1000	512**
192	1016**	1000
200	1024	1024
250	1250***	1800***
256		2000
360		2048
400		2500***

Options:
I = Index (3rd channel).
L = Agilent compatible pin-out.

Notes:
* Recommended for use with the Motion Control Building Block.
** Index option not available.
*** 32, 64, 720, 900, 1250, 1800, 2500 CPR only available with index.

Motor with Optical Encoder:

E5D Standard:	E5D Index/HiRes: (Hi Res >=1000 CPR)	E5S Standard:	E5S Index/HiRes: (Hi Res >=1000 CPR)	E6D Standard:	E6D Index/HiRes: (Hi Res >=2000 CPR)	E6S Standard:	E6S Index/HiRes: (Hi Res >=2000 CPR)
$116.55 / 1	$125.83 / 1	$102.90 / 1	$112.32 / 1	$127.05 / 1	$136.82 / 1	$113.40 / 1	$122.66 / 1
$104.22 / 10	$112.48 / 10	$92.09 / 10	$100.47 / 10	$116.55 / 10	$125.69 / 10	$102.90 / 10	$111.41 / 10
$91.82 / 50	$98.86 / 50	$81.47 / 50	$88.62 / 50	$107.10 / 50	$115.61 / 50	$93.45 / 50	$101.20 / 50
$81.87 / 100	$88.11 / 100	$72.68 / 100	$79.01 / 100	$98.70 / 100	$106.73 / 100	$86.10 / 100	$93.47 / 100
$73.52 / 500	$79.06 / 500	$65.38 / 500	$71.00 / 500	$92.40 / 500	$100.12 / 500	$80.85 / 500	$88.03 / 500
$68.03 / 1K	$72.99 / 1K	$60.73 / 1K	$65.76 / 1K	$86.10 / 1K	$93.19 / 1K	$75.60 / 1K	$82.22 / 1K

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