CHAPTER FOUR

4 Step Motors

Recommended Drive/Motor Systems

We recommend you use the following motors with drives listed in the *Recommended Drive Type* column.

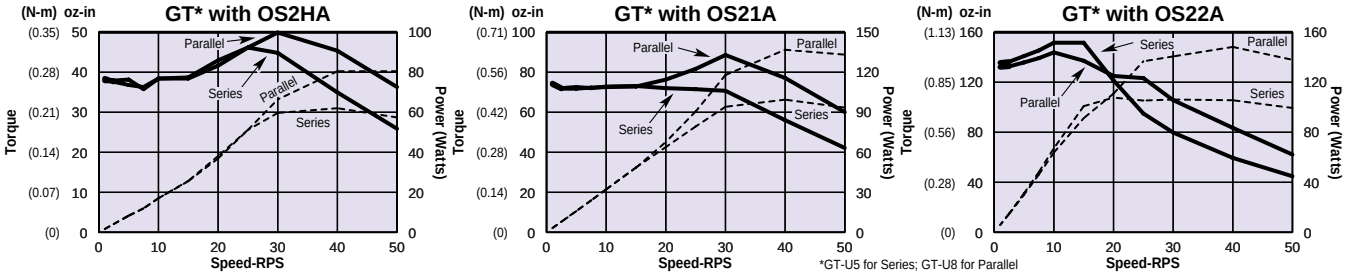
Motor Model Number	Drive Type Recommended
OS2HA-xxFLY (series)	GT-U5
OS21A-xxFLY (series)	GT-U5
OS22A-xxFLY (series)	GT-U5
OS2HA-xxL10 (series)	GT-U5
OS21A-xxL10 (series)	GT-U5
OS22A-xxL10 (series)	GT-U5
OS2HA-xxFLY (parallel)	GT-U8
OS21A-xxFLY (parallel)	GT-U8
OS22A-xxFLY (parallel)	GT-U8
OS2HA-xxL10 (parallel)	GT-U8
OS21A-xxL10 (parallel)	GT-U8
OS22A-xxL10 (parallel)	GT-U8
OS2HB-xxFLY (series)	GT-L5
OS21B-xxFLY (series)	GT-L5
OS22B-xxFLY (series)	GT-L5
OS2HB-xxL10 (series)	GT-L5
OS21B-xxL10 (series)	GT-L5
OS22B-xxL10 (series)	GT-L5
OS2HB-xxFLY (parallel)	GT-L5
OS21B-xxFLY (parallel)	GT-L5
OS22B-xxFLY (parallel)	GT-L5
OS2HB-xxL10 (parallel)	GT-L5
OS21B-xxL10 (parallel)	GT-L5
OS22B-xxL10 (parallel)	GT-L5
RS31B-xxS10 (series)	GT-L5
RS32B-xxS10 (series)	GT-L8
RS33B-xxS10 (series)	GT-L8
RS31B-xxP10 (parallel)	GT-L8
RS32B-xxP10 (parallel)	GT-L8
RS33B-xxP10 (parallel)	GT-L8

Motor Model Number	Drive Type Recommended	
RS42B-xxS10 (series)	GT-L8	
RE42B-xxS10 (series)	GT-L8	
RS42B-xxP10 (parallel)	GT-L8	
RE42B-xxP10 (parallel)	GT-L8	
TS31B-xxS10 (series)	GT-L5	
TS32B-xxS10 (series)	GT-L8	
TS33B-xxS10 (series)	GT-L8	
TS31B-xxP10 (parallel)	GT-L8	
TS32B-xxP10 (parallel)	GT-L8	
TS33B-xxP10 (parallel)	GT-L8	
TS41B-xxS10 (series)	GT-L8	
TS42B-xxS10 (series)	GT-L8	
TS43B-xxS10 (series)	GT-L8	
TS41B-xxP10 (parallel)	GT-L8	
TS42B-xxP10 (parallel)	GT-L8	
TS43B-xxP10 (parallel)	GT-L8	
		Equivalent to:
ES21B-xxR10 (series)	GT-L5	(ZETA57-51S)
ES22B-xxR10 (series)	GT-L5	(ZETA57-83S)
ES23B-xxR10 (series)	GT-L5	(ZETA57-102S)
ES21B-xxR10 (parallel)	GT-L5	(ZETA57-51P)
ES22B-xxR10 (parallel)	GT-L5	(ZETA57-83P)
ES23B-xxR10 (parallel)	GT-L5	(ZETA57-102P)
ES31B-xxR10 (series)	GT-L5	(ZETA83-62S)
ES32B-xxR10 (series)	GT-L5	(ZETA83-93S)
ES33B-xxR10 (series)	GT-L5	(ZETA83-135S)
ES31B-xxR10 (parallel)	GT-L5	(ZETA83-62P)
ES32B-xxR10 (parallel)	GT-L8	(ZETA83-93P)
ES33B-xxR10 (parallel)	GT-L8	(ZETA83-135P)

Speed/Torque Curves

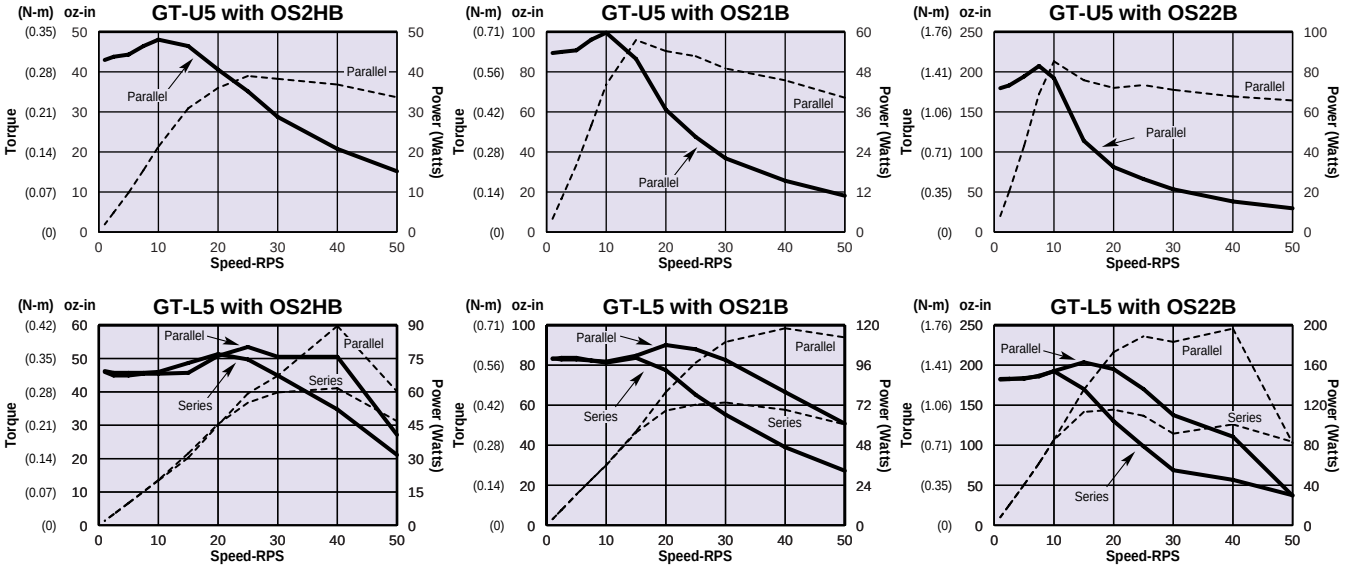
O Series Motors, “A” Windings

Size 23 Frame

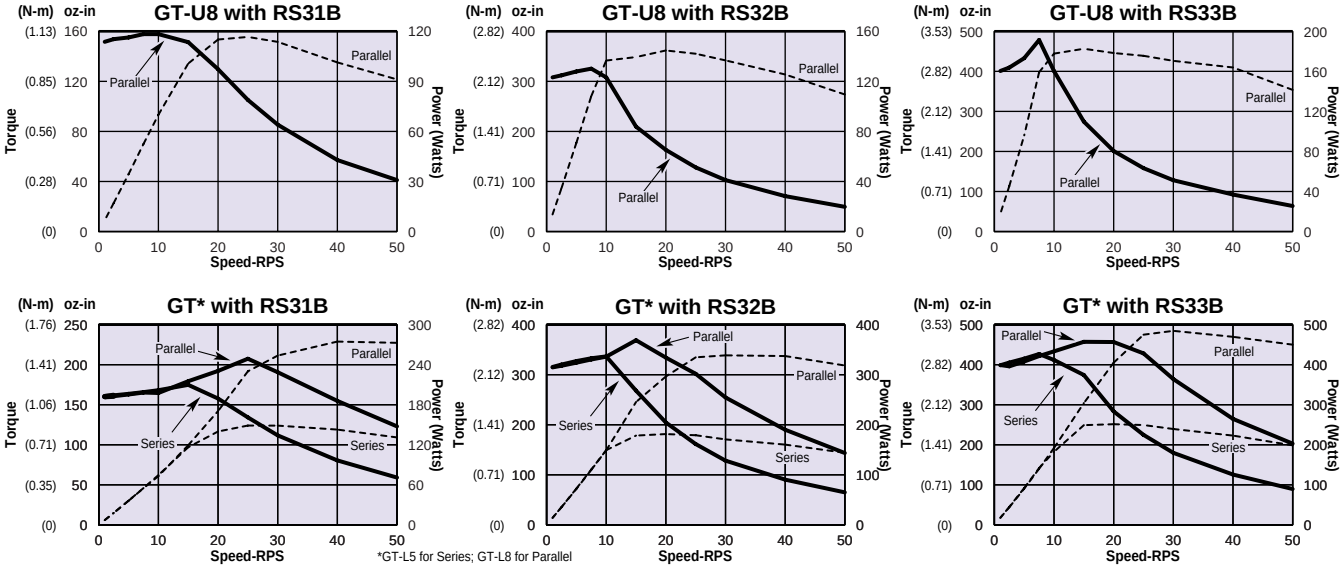


O Series Motors, “B” Windings

Size 23 Frame

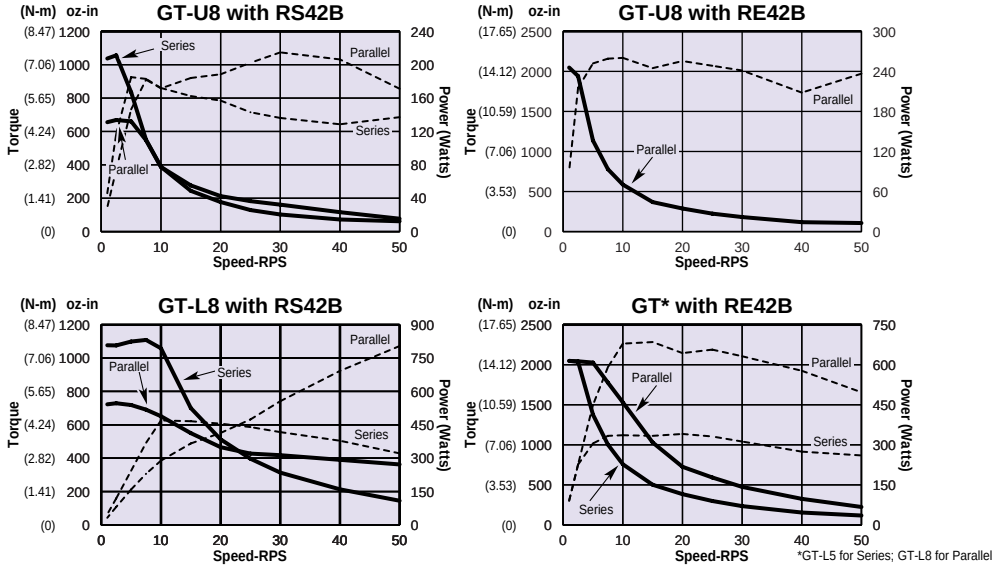


R Series Motors,
Size 34 Frame



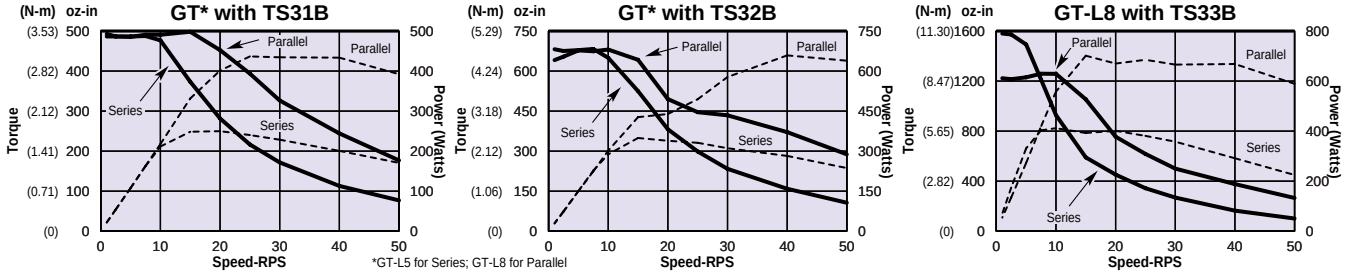
*GT-L5 for Series; GT-L8 for Parallel

R Series Motors,
Size 42 Frame

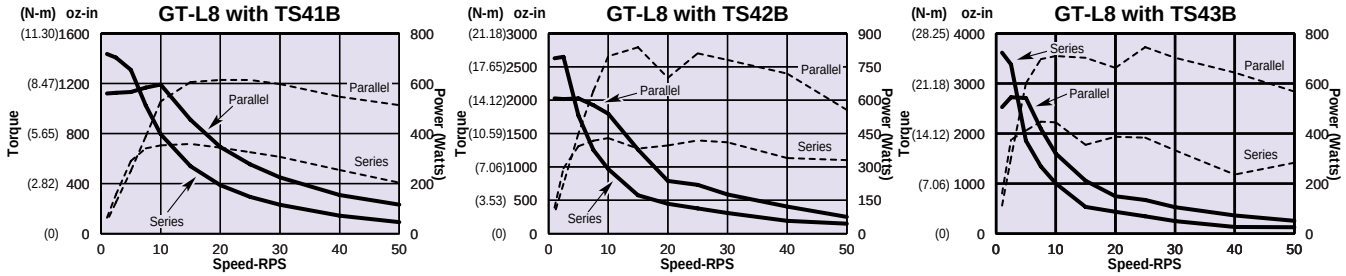


*GT-L5 for Series; GT-L8 for Parallel

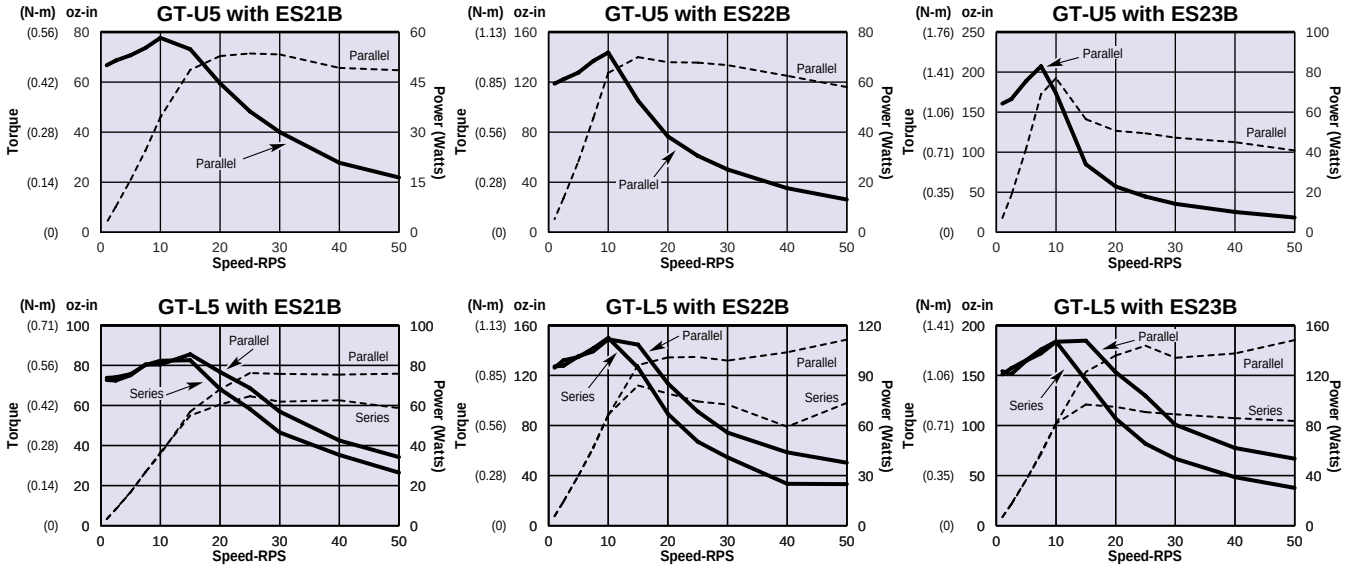
T Series Motors,
Size 34 Frame



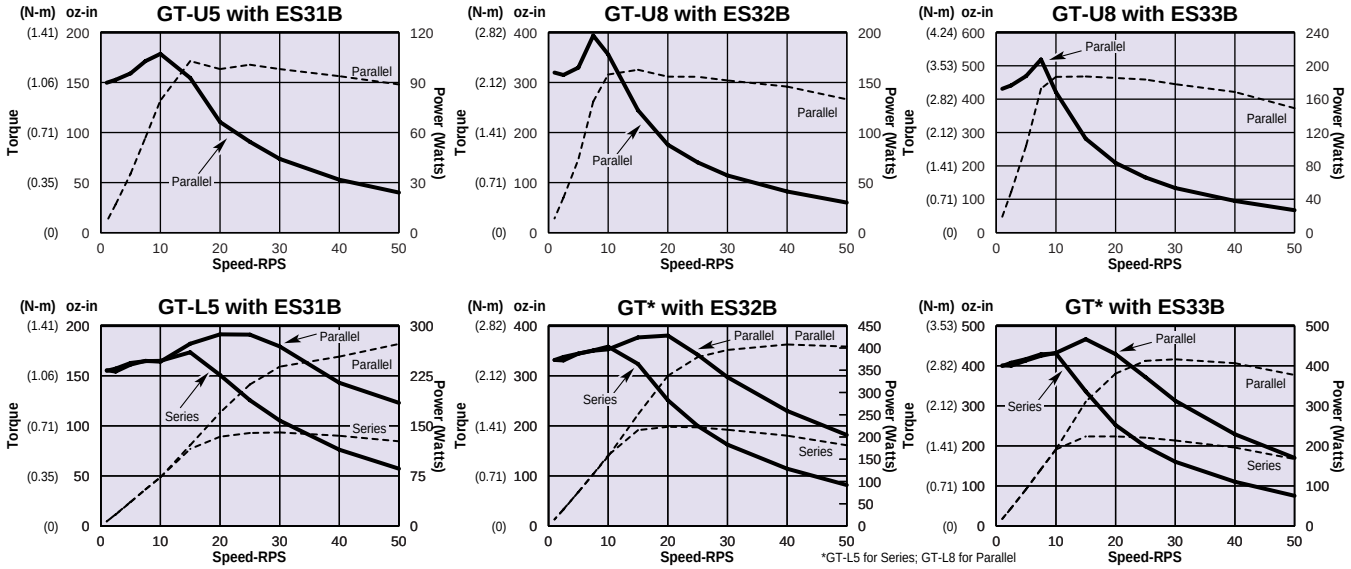
T Series Motors,
Size 42 Frame



E Series Motors,
Size 23 Frame



E Series Motors,
Size 34 Frame



*GT-L5 for Series; GT-L8 for Parallel

Specifications

O Series Motors with "A" Windings (75VDC Motors)

	Size 23 Frame		
	OS2HA	**OS21A**	**OS22A**
Static torque			
oz-in	37	66	133
(Nm)	(0.26)	(0.47)	(0.94)
Rotor inertia			
oz-in^2	0.386	0.656	1.390
(kg-cm^2)	(0.070)	(0.119)	(0.253)
Drive Current (Apk)(Arms)			
Series	2.65 (1.9)	3.3 (2.3)	3.8 (2.7)
Parallel	5.3 (3.7)	6.6 (4.7)	7.5 (5.3)
Phase Inductance (mH)			
Series	1.7	1.8	2.8
Parallel	0.4	0.4	0.7
Detent Torque			
oz-in	2.5	4.0	7.0
(Nm)	(0.018)	(0.028)	(0.049)
Bearings Information			
Thrust Load			
lb	13	13	13
(kg)	(5.9)	(5.9)	(5.9)
Radial Load			
lb	20	20	20
(kg)	(9.1)	(9.1)	(9.1)
End Play *(Reversing load equal to 1 lb)*			
in	0.001	0.001	0.001
(mm)	(0.025)	(0.025)	(0.025)
Radial Play *(Per 0.5 lb load)*			
in	0.0008	0.0008	0.0008
(mm)	(0.02)	(0.02)	(0.02)
Motor Weight			
lb	1	1.5	2.5
(kg)	(0.45)	(0.68)	(1.14)
Certifications			
UL recognized	Pending	Pending	Pending
CE (LVD)	Yes	Yes	Yes
CE (EMC & LVD)	No	No	No

O Series Motors with "B" Windings (170VDC Motors)
R Series Motors

	Size 23 Frame			Size 34 Frame			Size 42 Frame	
Parameters	**OS2HB**	**OS21B**	**OS22B**	**RS31B**	**RS32B**	**RS33B**	**RS42B**	**RE42B**
Static torque**								
oz-in	43	82	155	133	267	392	985	1907
(Nm)	(0.30)	(0.58)	(1.09)	(0.93)	(1.87)	(2.74)	(6.90)	(13.35)
Rotor inertia								
oz-in^2	0.39	0.66	1.39	3.02	6.56	9.65	61.76	61.76
(kg-cm^2)	(0.07)	(0.12)	(0.25)	(0.55)	(1.20)	(1.77)	(11.30)	(11.30)
Drive Current (Apk)(Arms)**								
Series	1.5 (1.0)	1.8 (1.3)	2.2 (1.5)	2.3 (1.6)	2.8 (2.0)	3.4 (2.4)	6.1 (4.3)	3.4 (2.4)
Parallel	3.0 (2.1)	4.0 (2.8)	4.0 (2.8)	4.6 (3.3)	5.6 (4.0)	6.9 (4.9)	12.0 (8.5)	7.2 (5.1)
Phase Inductance (mH)***								
Series	8.6	12	16.6	9.4	11.6	9.6	8.2	42.6
Parallel	2.2	3	4.2	2.4	2.9	2.4	2.1	10.7
Drive Bus Voltage (VDC)	170	170	170	170	170	170	170	170
Detent Torque								
oz-in	2.5	4.0	7.0	8.8	18.0	27.0	41.7	81.0
(Nm)	(0.02)	(0.03)	(0.05)	(0.06)	(0.13)	(0.19)	(0.35)	(0.57)
Bearings Information								
Thrust Load								
lb	13	13	13	180	180	180	400	400
(kg)	(5.9)	(5.9)	(5.9)	(81.6)	(81.6)	(81.6)	(182)	(182)
Radial Load								
lb	20	20	20	35	35	35	140	140
(kg)	(9.1)	(9.1)	(9.1)	(15.9)	(15.9)	(15.9)	63.6)	(63.6)
End Play (Reversing load equal to 1 lb)								
in	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
(mm)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Radial Play (Per 0.5 lb load)								
in	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
(mm)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Motor Weight								
lb	1	1.5	2.5	3.2	5.3	7.6	18.2	18.2
(kg)	(0.5)	(0.7)	(1.1)	(1.5)	(2.4)	(3.5)	(8.3)	(8.3)
Certifications								
UL recognized	No	No	No	Yes	Yes	Yes	Yes	Yes
CE (LVD)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CE (EMC & LVD)*	No	No	No	*	*	*	*	*

T Series Motors

	Size 34 Frame			Size 42 Frame		
Parameters	**TS31B**	**TS32B**	**TS33B**	**TS41B**	**TS42B**	**TS43B**
Static torque**						
oz-in	455	647	1525	1332	2515	3479
(N-m)	(3.19)	(4.53)	(10.68)	(9.32)	(17.61)	(24.35)
Rotor inertia						
oz-in^2	7.80	14.67	21.89	30.22	59.68	88.51
(kg-cm^2)	(1.43)	(2.68)	(4.01)	(5.53)	(10.92)	(16.20)
Drive Current (Apk)(Arms)**						
Series	3.3 (2.3)	3.1 (2.2)	5.6 (4.0)	6.4 (4.5)	6.7 (4.7)	6.9 (4.9)
Parallel	6.7 (4.7)	6.2 (4.4)	12.0 (8.5)	12.0 (8.5)	12.0 (8.5)	12.0 (8.5)
Drive Bus Voltage (VDC)	170	170	170	170	170	170
Phase Inductance (mH)***						
Series	10.3	10.3	13.6	15.8	22.0	30.7
Parallel	2.6	2.6	3.4	3.9	5.5	7.7
Detent Torque						
oz-in	18	36	54	42	84	106
(Nm)	(0.13)	(0.25)	(0.38)	(0.30)	(0.59)	(0.75)
Bearings Information						
Thrust Load						
lb	305	305	305	404	404	404
(kg)	(139)	(139)	(139)	(184)	(184)	(184)
Radial Load						
lb	65	65	110	125	110	110
(kg)	(30)	(30)	(50)	(57)	(50)	(50)
End Play *(Reversing load equal to 1 lb)*						
in	0.001	0.001	0.001	0.001	0.001	0.001
(mm)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Radial Play *(Per 0.5 lb load)*						
in	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
(mm)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Motor Weight						
lb	5.0	8.4	11.9	11.0	18.4	25.7
(kg)	(2.3)	(3.8)	(5.4)	(5.0)	(8.4)	(11.7)
Certifications						
UL recognized	Yes	Yes	Yes	Yes	Yes	Yes
CE (LVD)	Yes	Yes	Yes	Yes	Yes	Yes
CE (EMC & LVD)*	*	*	*	*	*	*

E Series Motors

Parameters		Size 23 Frame ES21-xxR10 (ZETA57-51)	Size 23 Frame ES22-xxR10 (ZETA57-83)	Size 23 Frame ES23-xxR10 (ZETA57-102)	Size 34 Frame ES31-xxR10 (ZETA83-62)	Size 34 Frame ES32-xxR10 (ZETA83-93)	Size 34 Frame ES33-xxR10 (ZETA83-135)
Static torque							
oz-in		65	125	145	145	300	380
(N-m)		(0.46)	(0.88)	(1.02)	(1.02)	(2.12)	(2.68)
Rotor inertia							
oz-in^2		0.546	1.10	1.69	3.47	6.76	10.47
(kg-cm^2)		(0.100)	(0.201)	(0.309)	(0.635)	(1.24)	(1.92)
Phase Inductance (mH)							
Series	mH (small signal*)	17.37	18.5	17	10	10.5	9.2
	mH (large signal**)	26.3	26.86	24.6	14.44	15.54	13.89
Parallel	mH (small signal*)	4.34	4.62	4.25	2.5	2.62	2.3
	mH (large signal**)	6.57	6.71	6.15	3.61	3.88	3.47
Bearings Information							
Thrust Load							
lb		25	25	25	50	50	50
(kg)		(11.3)	(11.3)	(11.3)	(22.6)	(22.6)	(22.6)
Radial Load							
lb		15	15	15	25	25	25
(kg)		(6.8)	(6.8)	(6.8)	(11.3)	(11.3)	(11.3)
End Play ***(Reversing load equal to 1 lb)***							
in		0.005	0.005	0.005	0.005	0.005	0.005
(mm)		(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Radial Play ***(Per 0.5 lb load)***							
in		0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
(mm)		(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Motor Weight ***(Motor + Cable + Connector)***							
lb		1.6	2.4	3.2	3.8	5.1	8.3
(kg)		(0.7)	(1.1)	(1.5)	(1.7)	(2.3)	(3.8)
Motor Cable Wire Size							
AWG		24	24	24	22	22	22
(mm^2)		(0.25)	(0.25)	(0.25)	(0.34)	(0.34)	(0.34)

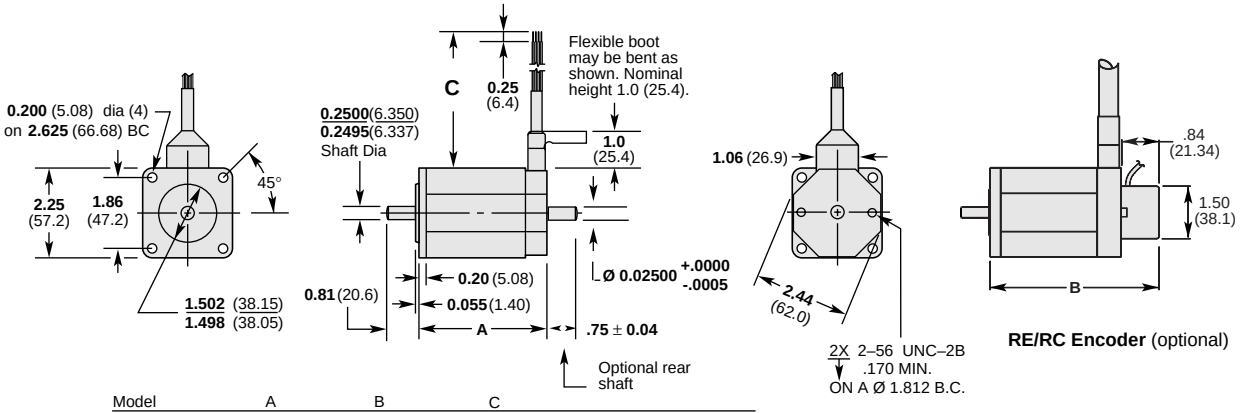
All motors: R10 cable length = 10 ft (3 m); flying leads (no connector) on end.

* Small Signal Inductance is found by using an inductance bridge or meter.
** Large Signal Inductance is found by measuring actual generator AC flux linkage and generator short circuit current under dynamic conditions.

Dimensions

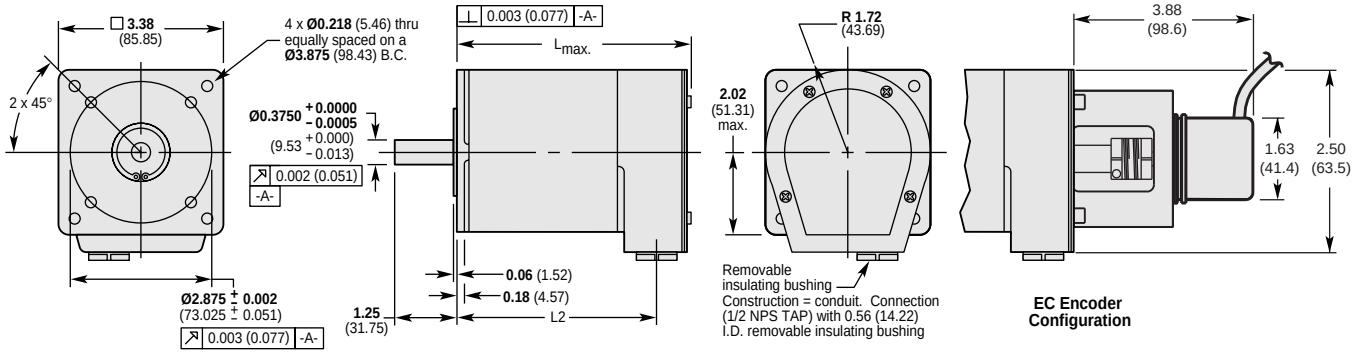
Dimensions in inches (mm)

O Series Motors, Size 23 Frame

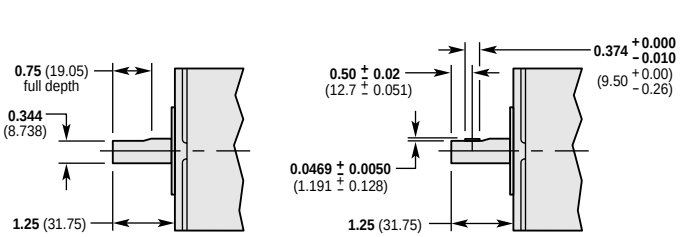


Model	A	B	C
OS2HA, OS2HB	**1.60** (40.7)	**2.44** (62.0)	For flying leads (FLY) – 13.5 (343) min.
OS21A, OS21B	**2.06** (52.4)	**2.90** (73.7)	For 10 ft cable (L10) – 120.0 (3048)
OS22A, OS22B	**3.10** (78.8)	**3.94** (100.1)	

R Series Motors, Size 34 Frame

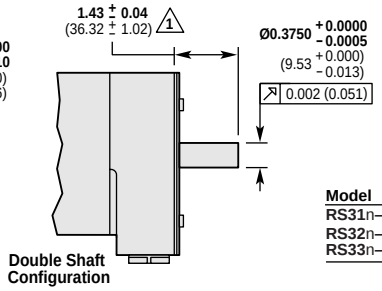


Standard Front Shaft Configurations



Flat Configuration = F

#303 Woodruff Key Configuration = W

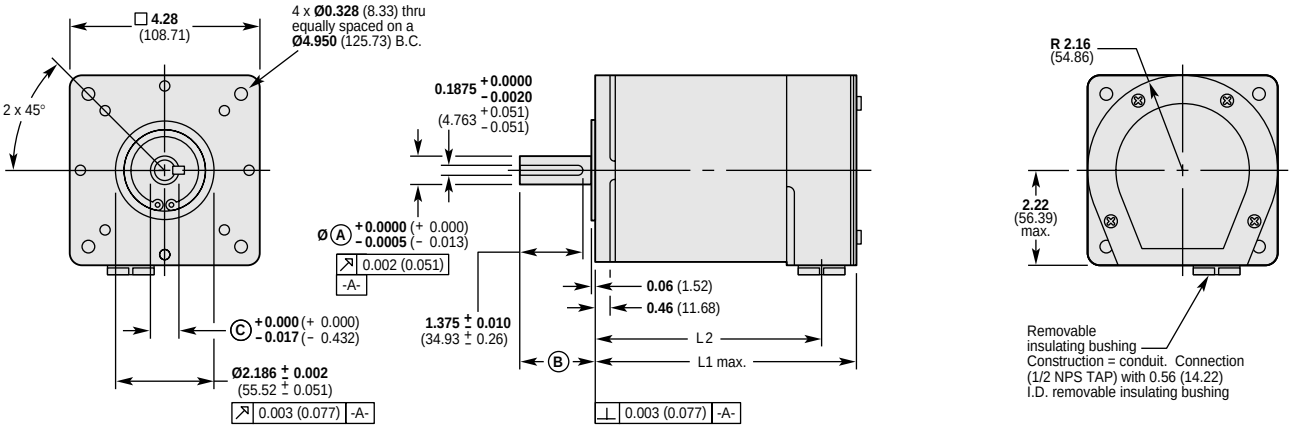


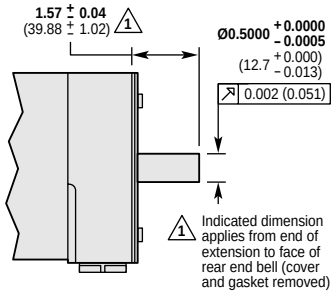
Double Shaft Configuration

1 Indicated dimension applies from end of extension to face of rear end bell (cover and gasket removed)

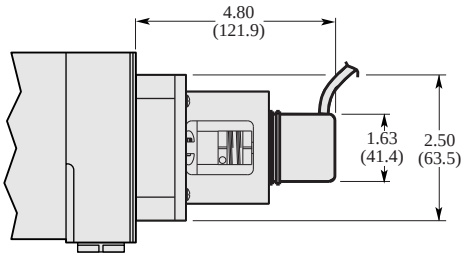
Model	Lmax	L2
RS31n–nnn**NPS**	**3.62** (91.95)	**2.87** (72.9)
RS32n–nnn**NPS**	**4.77** (121.16)	**4.02** (102.11)
RS33n–nnn**NPS**	**6.05** (153.67)	**5.30** (134.62)

R Series Motors, Size 42 Frame

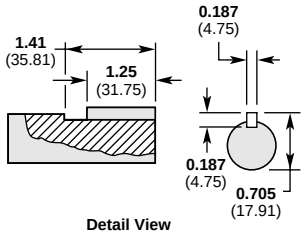




Double Shaft Configuration



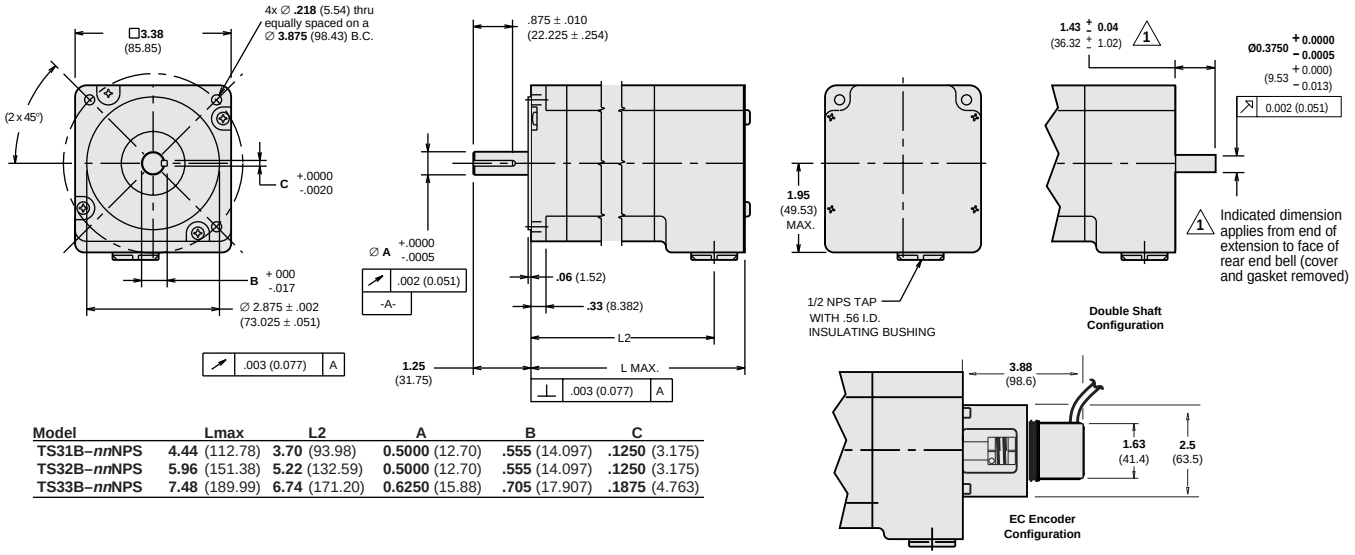
EC Encoder Configuration



Detail View

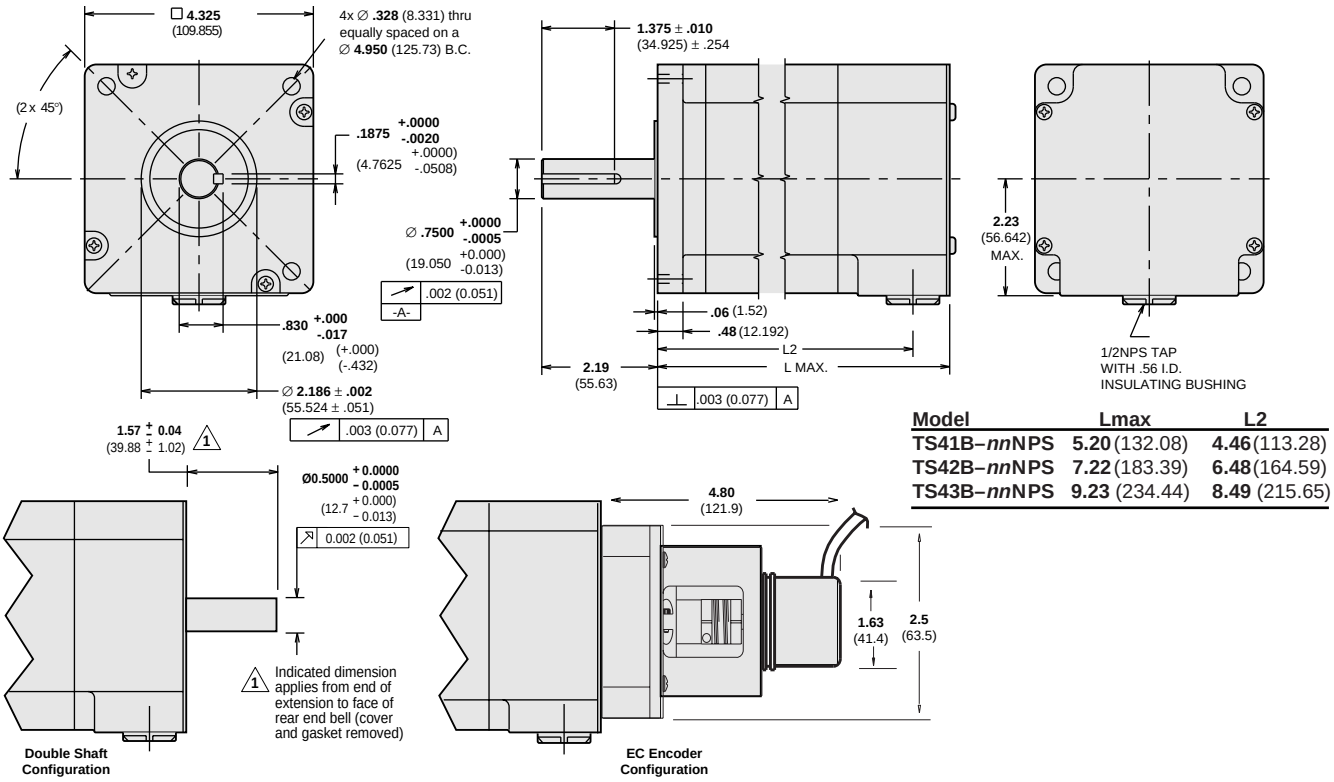
Model	Lmax	L2	A	B	C
RS42n–nnn**NPS**	**8.04** (204.22)	**7.29** (185.17)	**0.625** (15.87)	**2.19** (55.63)	**0.705** (17.91)
RE42n–nnn**NPS**	**8.04** (204.22)	**7.29** (185.17)	**0.625** (15.87)	**2.19** (55.63)	**0.705** (17.91)
RE43n–nnn**NPS**	**10.56** (268.23)	**9.81** (249.18)	**0.75** (19.05)	**2.19** (55.63)	**0.83** (21.09)

T Series Motors, Size 34 Frame



Model	Lmax	L2	A	B	C
TS31B–*nn*NPS	**4.44** (112.78)	**3.70** (93.98)	**0.5000** (12.70)	**.555** (14.097)	**.1250** (3.175)
TS32B–*nn*NPS	**5.96** (151.38)	**5.22** (132.59)	**0.5000** (12.70)	**.555** (14.097)	**.1250** (3.175)
TS33B–*nn*NPS	**7.48** (189.99)	**6.74** (171.20)	**0.6250** (15.88)	**.705** (17.907)	**.1875** (4.763)

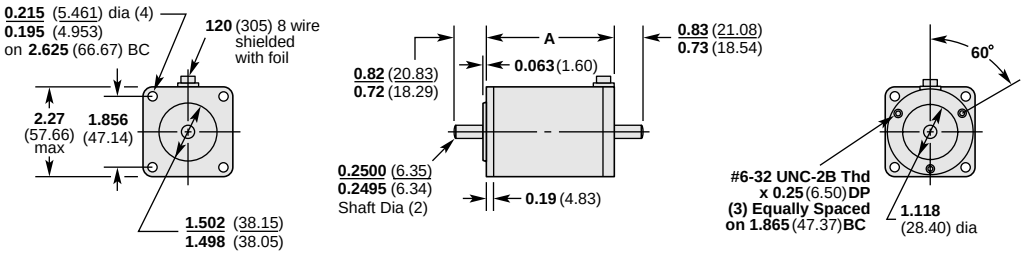
T Series Motors, Size 42 Frame



Model	Lmax	L2
TS41B–*nn*NPS	**5.20**(132.08)	**4.46**(113.28)
TS42B–*nn*NPS	**7.22**(183.39)	**6.48**(164.59)
TS43B–*nn*NPS	**9.23** (234.44)	**8.49** (215.65)

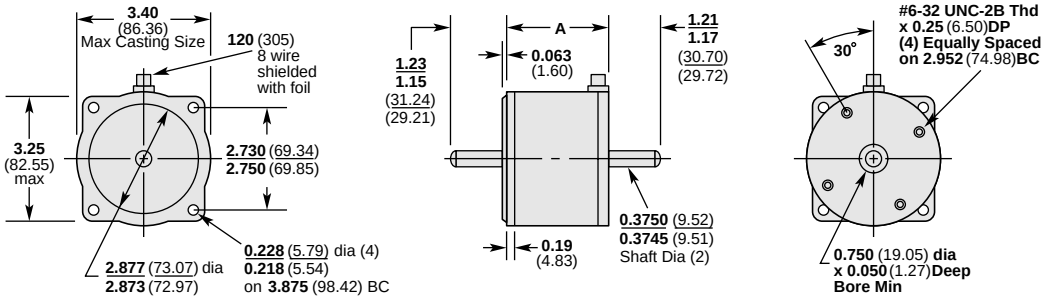
E Series Motors, Size 23 Frame

Model	A
ES21B	**2.0** (50.23)
ES22B	**3.1** (75.23)
ES23B	**4.0** (101.6)



E Series Motors, Size 34 Frame

Model	A
ES31B	**2.5** (62.0)
ES32B	**3.7** (93.98)
ES33B	**5.2** (129.0)



Step Motor Wiring

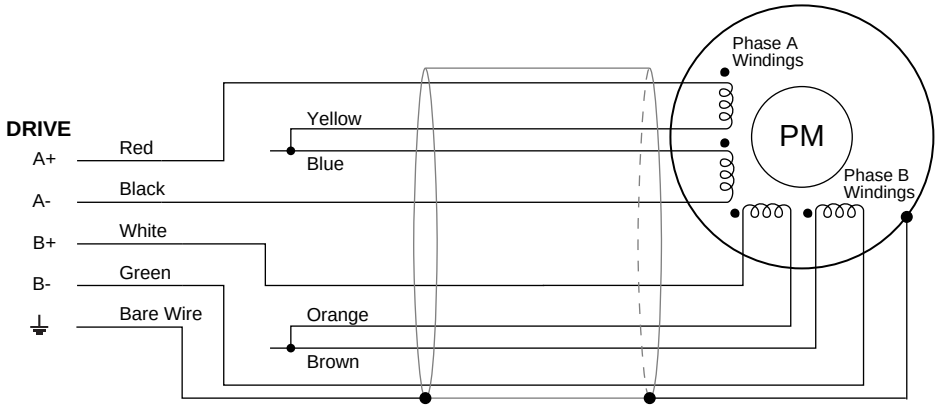
O Motors and E Motors

O and E motors can be wired in series or parallel. The following cabling options are available:

Motor	Option	Description of Option:	Cable Length:
O	-FLY	Regular construction with 8 flying leads,	12 inches (0.3 m)
	-L10	Regular construction with LVD cable,	10 feet (3 m)
E	-R10	Regular construction, cable, with flying leads	10 feet (3 m)

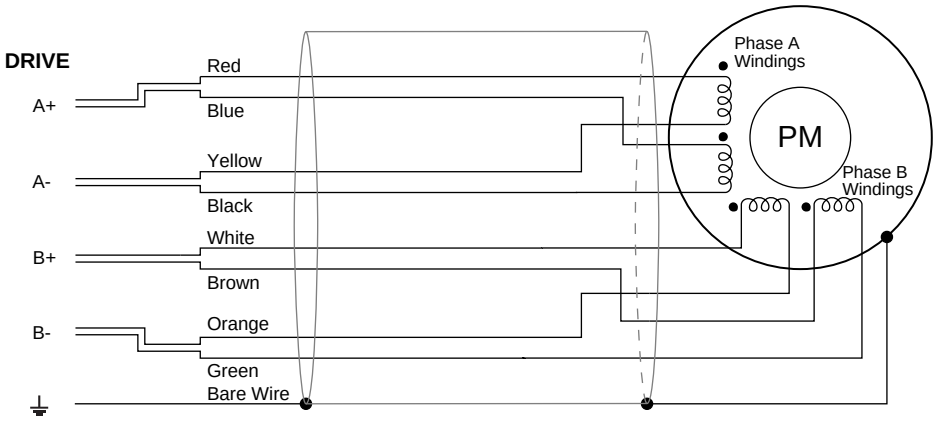
Series Wiring

O or E Motor – Series Wiring



Parallel Wiring

O or E Motor – Parallel Wiring



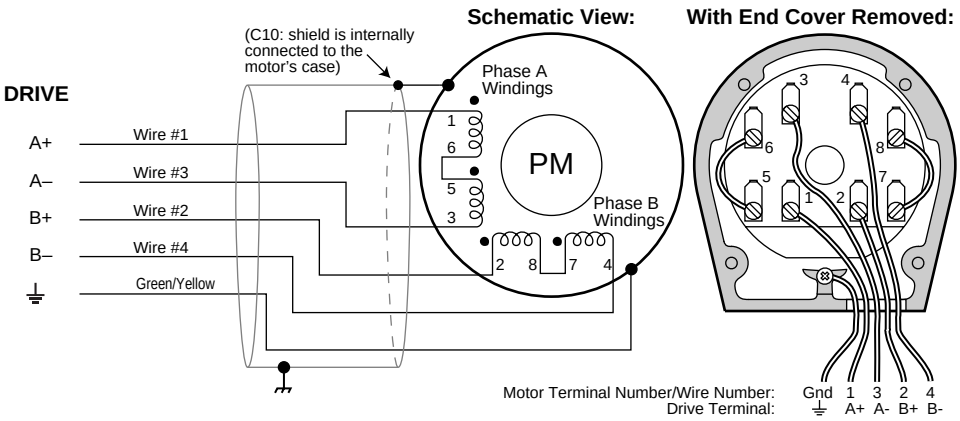
R Motors and T Motors

The following cabling options are available for R and T motors:

Option	Description of Option:	Cable Length:
NPS	End bell/terminal board with 1/2" NPS pipe thread	No cable
S10	CE (LVD)/UL, NPS construction, motor wired in series	10 feet (3 m)
P10	CE (LVD)/UL, NPS construction, motor wired in parallel	10 feet (3 m)

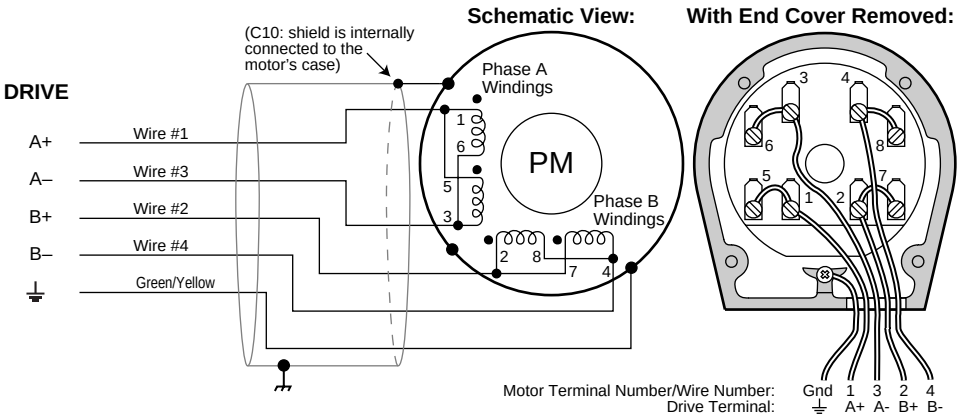
Series Wiring

R or T Motor – Series Wiring



Parallel Wiring

R or T Motor – Parallel Wiring



Encoder Information

Encoder Specifications

	-E and -EC Encoders	-RE and -RC Encoders
Mechanical		
Starting Torque at 77°F (25°C)		
	oz-in 0.5	Not applicable
	(Nm) (0.003)	Not applicable
Moment of inertia		
	oz-in sec^2 0.22	4.4×10^{-5}
Weight		
	oz 10	2
	(kg) (0.28)	(0.057)
Bearing Life		
	Revolutions $1x10^9$	Not applicable
Max operating speed	3,000 rpm	6,000 rpm
Electrical		
Input power	5VDC±5%, 125mA	5VDC±5%, 135mA
Output format	2 channels (A and B) quadrature Z channel once/rev	2 channels (A and B) quadrature Z channel once/rev
Environmental		
Operating Temperature	32°F to 158°F (0°C to 70°C)	14°F to 185°F (-10°C to 85°C)
Storage Temperature	32°F to 158°F (0°C to 70°C)	-22°F to 230°F (-30°C to 110°C)
Shock	10 G's for 11 msec duration	50 G's for 11 msec duration
Vibration	5 G's at 10 Hz to 2,000 Hz	10 G's at 20 Hz to 2,000 Hz

Encoder Cable – Color Code

-E and -EC option encoders come standard with a 10-foot cable and 25-pin D-connector.

-RE option encoders come standard with 13 inch flying leads.

-RC option encoders come standard with a 10-foot cable.

25-Pin D No. (E/EC only):	Color Code – All Encoders Color:	Description:
1	Brown	Channel A
2	Brown/White	Channel A return
3	Green	Channel B
4	Green/White	Channel B return
5	Orange	Channel Z
6	Orange/White	Channel Z return
7	—	NC
8	Shield	Case ground
9 – 13	—	NC
14	Black	Common
15 – 22	—	NC
23	Red	5VDC
24 – 25	—	NC

Encoder Dimensions

Encoder dimensions are shown in the dimension drawing for each motor.