

# I-FORCE Ironless linear motors



Parker Trilogly's I-Force ironless linear motors offer high forces and rapid accelerations in a compact package. With forces ranging from 5.5 lbf (24.5 N) - 197.5 lbf (878.6 N) continuous up to 5.5 lbf (24.5 N) - (883 lbf (3928 N) peak, the I-Force family offers a superior combination of performance and size.

The I-Force patented I-beam shape with its overlapping windings allows for a higher power density in a smaller motor, improved heat removal, and added structural stiffness. In addition, the ironless (or air core) linear motor design has no attractive force toward the magnets. This allows for easy installation and zero cogging during motion.

Ultra high-flex cables come standard with I-Force motors. In addition, we offer modular magnet tracks for unrestricted travel length. Incredibly smooth motion, high precision and high force density make the I-Force linear motors an ideal solution for your demanding positioning requirements.

## **Overlapping Windings:**

- Increased force density
- Improved heat dissipation
- Lower temperature rise
- Smaller, less expensive motor

## **No attractive force toward the magnets:**

- Easier/Safer assembly and handling, smoother travel (no cogging)

## **Uses thermally conductive epoxy together with the windings (Patented RE34674):**

- Better heat dissipation

## **Vacuum encapsulation process:**

- Allows motors to be used in high-vacuum environments (Rated at  $10^{-6}$  torr, currently used in  $10^{-7}$  torr applications)

## **Modular magnet track:**

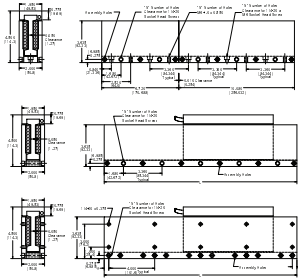
- Unrestricted travel length

## **Embedded overtemp thermostat or optional thermistor:**

- Protects windings against overheating

## **Ultra high-flex cables:**

- Longer cable life, good for millions of cycles



### I-FORCE

- Ironless motor, patented, RE34674
- Cross-section: 2.05”H (50mm) x 0.82”W (21mm)
- Peak forces in two sizes to 45lbs (200N), continuous forces to 10lbs (44N)
- Precision ground 3-piece track (110 model)
- Two lengths of modular magnet tracks allow unlimited length of travel
- Single-piece magnet tracks to 36” length
- Prealigned imbedded digital Hall effect devices
- Internal thermal cutout switch protects coil

### PERFORMANCE

MOTOR MODEL		110-1	110-2
Peak Force	N	108.5	202.5
	lb	24.4	45.5
Continuous Force	N	24.5	45.4
	lb	5.5	10.2
Peak Power	W	938	1641
Continuous Power	W	47	82

### ELECTRICAL

MOTOR MODEL		110-1			110-2		
WIRING TYPE	UNITS	S-Series	P-Parallel	T-Triple	S-Series	P-Parallel	T-Triple
Peak Current	A pk sine	15.9	31.8	47.7	14.8	29.6	44.4
	(RMS)	11.2	22.5	33.7	10.4	20.9	31.4
Continuous Current	A pk sine	3.6	7.2	10.8	3.3	6.6	9.9
	(RMS)	2.5	5.1	7.6	2.3	4.7	7.0
Force Constant	N/A peak	6.8	3.4	2.3	13.7	6.8	4.6
	lb/A peak	1.5	0.8	0.5	3.1	1.5	1.0
Back EMF	V/m/s	7.9	3.9	2.6	15.7	7.9	5.2
	V/in/s	0.20	0.10	0.07	0.40	0.20	0.13
Resistance 25°C, phase to phase	ohms	3.8	1.0	0.4	7.6	1.9	1.0
Inductance, phase to phase	mH	1.0	0.3	0.1	2.0	0.5	0.2
Electrical Time Constant	ms	0.3	0.3	0.3	0.3	0.3	0.3
Motor Constant	N/W	3.56	3.56	3.56	5.02	5.02	5.02
	lb/W	0.80	0.80	0.80	1.13	1.13	1.13
Max Terminal Voltage	VDC	330	330	330	330	330	330

### THERMAL

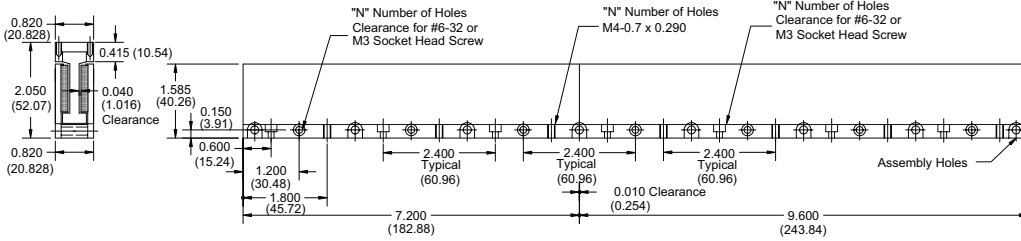
MOTOR MODEL		110-1	110-2
Thermal Resistance Wind-Amb	degC / W	1.59	0.92
Thermal Time Constant	min	3.2	3.2
Maximum Winding Temperature	°C	100	100

### MECHANICAL

MOTOR MODEL		110-1	110-2
Coil Weight	kg	0.12	0.22
	lb	0.27	0.48
Coil Length	mm	81.3	142.2
	in	3.20	5.60
Attractive Force	N	0	0
	lbf	0	0
Electrical Cycle Length	mm	60.96	60.96
	in	2.40	2.40

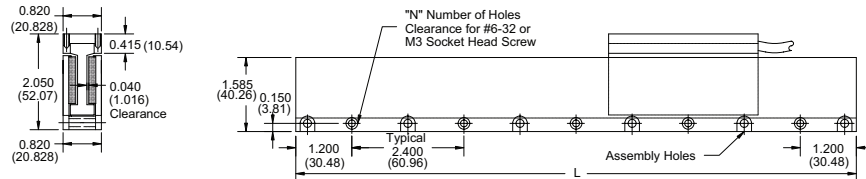


**MODULAR  
11007M  
11009M**



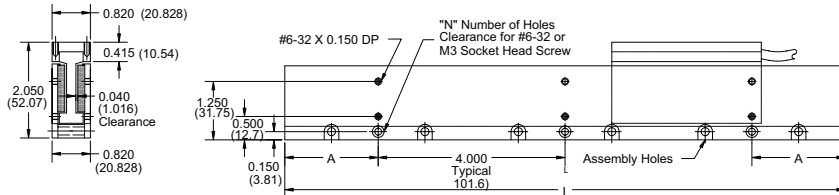
**Incremental Length:**  
2.4in/60.96mm  
**Minimum Length:**  
2.4in/60.96mm  
**Maximum Length:  
(For Single Piece)**  
36in/914.40mm  
**Weight/Foot:**  
2.66lbs/ft

**MODULAR  
110xxM1**



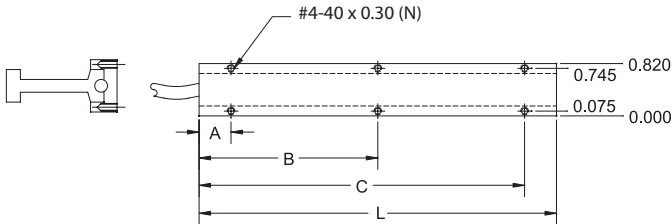
**Incremental Length:**  
2.4in/60.96mm  
**Minimum Length:**  
2.4in/60.96mm  
**Maximum Length:  
(For Single Piece)**  
36in/914.90mm  
**Weight/Foot:**  
2.66lbs/ft

**SINGLE PIECE  
110xxS**



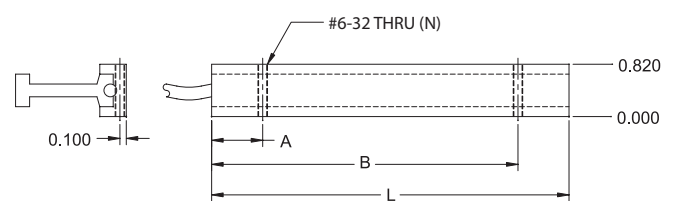
**Incremental Length:**  
1.2in/30.48mm  
**Minimum Length:**  
8.4in/213.4mm  
**Maximum Length:  
(For Single Piece)**  
36in/914.90mm  
**Weight/Foot:**  
2.66lbs/ft

**(A) ENGLISH TOP MOUNTING**



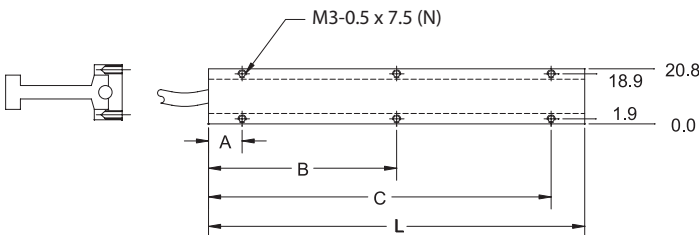
COIL SIZE (inches)	L	N	A	B	C
110-1A	3.20	4	0.50	2.70	---
110-2A	5.60	6	0.50	2.80	5.10

**(B) ENGLISH SIDE MOUNTING**



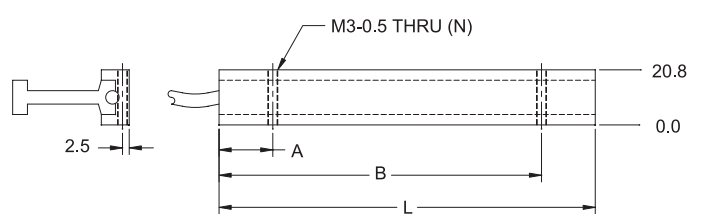
COIL SIZE (inches)	L	N	A	B
110-1B	3.20	2	0.80	2.40
110-2B	5.60	2	0.80	4.80

**(M) METRIC TOP MOUNTING**



COIL SIZE (mm)	L	N	A	B	C
110-1M	81.3	4	12.7	68.6	---
110-2M	142.2	6	12.7	71.1	129.5

**(N) METRIC SIDE MOUNTING**

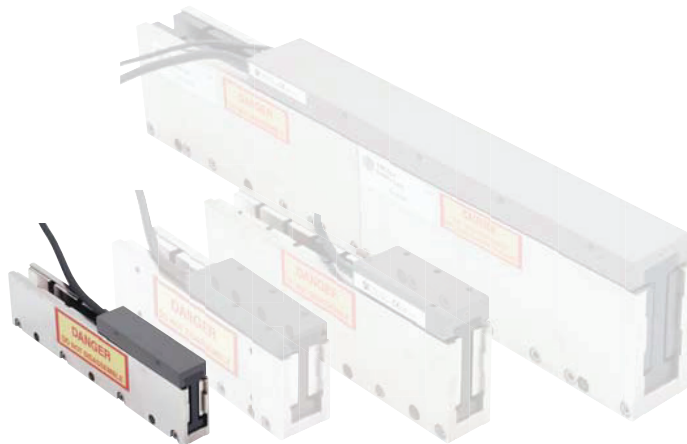


COIL SIZE (mm)	L	N	A	B
110-1N	81.3	2	20.3	60.9
110-2N	142.2	2	20.3	121.9

**MODULAR TRACK COMBINATIONS**

LENGTH In Inches	LENGTH In mm	QUANTITY 11007M	QUANTITY 11009M
7.2	182.9	1	0
9.6	243.8	0	1
12.0	304.8	0	0
14.4	365.8	2	0
16.8	426.7	1	1
19.2	487.7	0	2
21.6	548.6	3	0
24.0	609.6	2	1
26.4	670.6	1	2
28.8	731.5	0	3
31.2	792.5	3	1
33.6	853.4	2	2
36.0	914.4	1	3
38.4	975.4	0	4
40.8	1036.3	3	2
43.2	1097.3	2	3
45.6	1158.2	1	4
48.0	1219.2	0	5
50.4	1280.2	3	3
52.8	1341.1	2	4
55.2	1402.1	1	5
57.6	1463.0	0	6
60.0	1524.0	3	4
62.4	1585.0	2	5
64.8	1645.9	1	6
67.2	1706.9	0	7
69.6	1767.8	3	5
72.0	1828.8	2	6

\*Please note that 72.0 inches is NOT the maximum length for modular tracks.



**110xxS SINGLE PIECE**

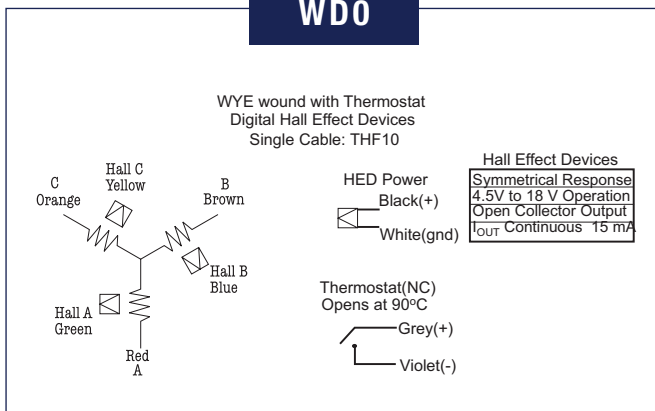
P/N	110xx	S	L (in)	L (mm)	A	mm	N
11008	S		8.4	205.8	0.20	5.08	3
11009	S		9.6	235.2	0.80	20.32	3
11010	S		10.8	264.6	1.40	35.56	3
11012	S		12.0	294.0	2.00	50.80	3
11013	S		13.2	323.4	2.60	66.04	3
11014	S		14.4	352.8	3.20	81.28	3
11015	S		15.6	382.2	3.80	96.52	3
11016	S		16.8	411.6	0.40	10.16	5
11018	S		18.0	441.0	1.00	25.40	5
11019	S		19.2	470.4	1.60	40.64	5
11020	S		20.4	499.8	2.20	55.88	5
11021	S		21.6	529.2	2.80	71.12	5
11022	S		22.8	558.6	3.40	86.36	5
11024	S		24.0	588.0	4.00	101.60	5
11025	S		25.2	617.4	0.60	15.24	7
11026	S		26.4	646.8	1.20	30.48	7
11027	S		27.6	676.2	1.80	45.72	7
11028	S		28.8	705.6	2.40	60.96	7
11030	S		30.0	735.0	3.00	76.20	7
11031	S		31.2	764.4	3.60	91.44	7
11032	S		32.4	793.8	0.20	5.08	9
11033	S		33.6	823.2	0.80	20.32	9
11034	S		34.8	852.6	1.40	35.56	9
11036	S		36.0	882.0	2.00	50.80	9

**110xxM and 110xxM1 MODULAR**

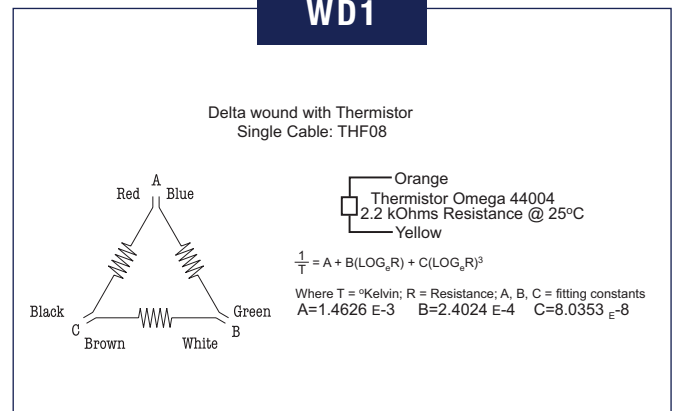
P/N	110xx	M/M1	L (in)	L (mm)	N
11002	M/M1		2.4	60.96	1
11004	M/M1		4.8	121.92	2
11007	M/M1		7.2	182.88	3
11009	M/M1		9.6	243.84	4
11012	M/M1		12.0	304.80	5
11014	M/M1		14.4	365.76	6
11016	M/M1		16.8	426.72	7
11019	M/M1		19.2	487.68	8
11021	M/M1		21.6	548.64	9
11024	M/M1		24.0	609.60	10
11026	M/M1		26.4	670.56	11
11028	M/M1		28.8	731.52	12
11031	M/M1		31.2	792.48	13
11033	M/M1		33.6	853.44	14
11036	M/M1		36.0	914.40	15



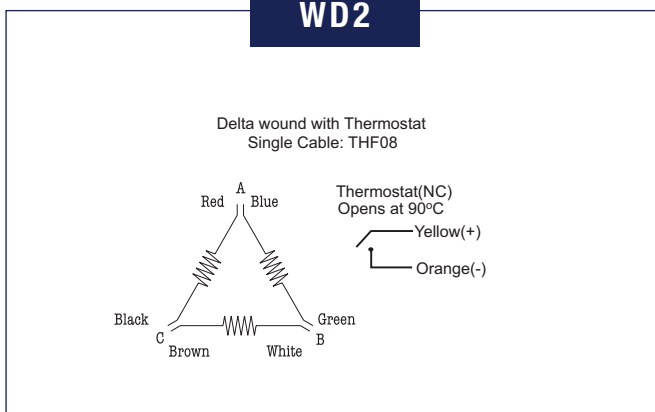
**WDO**



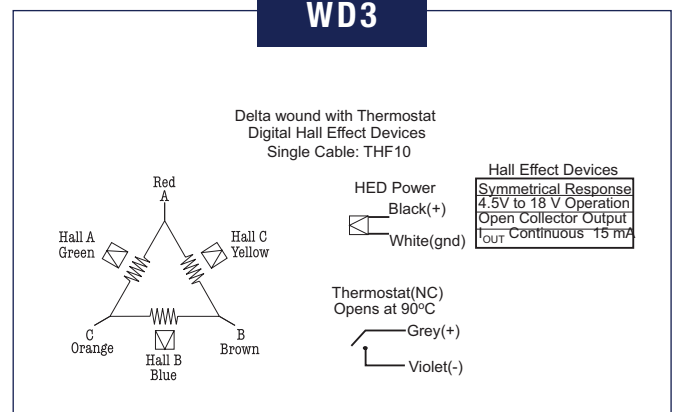
**WD1**



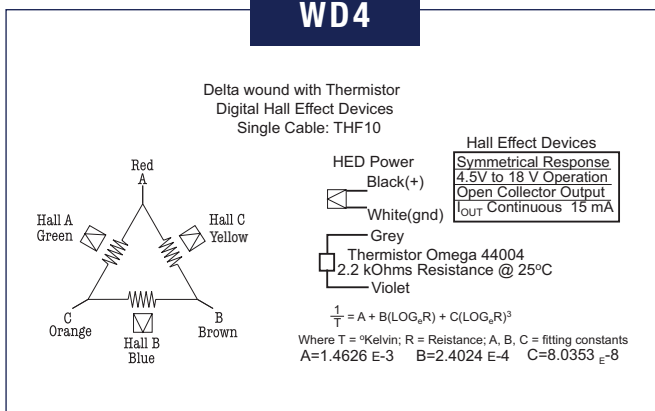
**WD2**



**WD3**



**WD4**



**NOTES**

1. Peak force and current based on 5% duty cycle and one second duration.
2. Continuous force and current based on coil winding temperature maintained at 100°C.
3. Force constant is peak of resistive force produced by 1.0 amp thru one motor lead and 0.5 amps thru other two leads. Also, Back EMF (V/in/sec) \* 7.665 = Force constant (lb/amp).
4. Motor resistance measured between any two motor leads with motor connected in Delta winding at 25°C. For temperature at 100°C, multiply resistance by 1.295 (75°C rise \* 0.393%/°C)
5. Back EMF measured between any two motor leads while moving at constant velocity. Value is amplitude or 0-Peak of sine wave produced.
6. Motor inductance measured using 1Kz with the motor in the magnetic field.
7. Electrical Time Constant is time it takes for motor value to reach 63% of its final current after a step change in voltage.

8. Thermal Time Constant is time it takes for motor temperature to reach 63% of its final value after a step change in power.
9. Thermal Resistance is the number of degrees (Celsius) of temperature rise in the winding per watt of power dissipated. Determined experimentally.
10. Motor Constant is a measure of efficiency. Calculated by dividing the force constant by the square root of the motor resistance at maximum operating temperature.
11. Electrical Cycle Length is distance coil must travel to complete 360° electrical cycle.
12. Use TIPS sizing software for the most accurate estimate of coil temperature for a particular motion profile.
13. Motors available with nickel plating or black epoxy coating on magnets. Track part number modified with -N or -B at end. Must be specified at time of order.
14. Electrical motor specifications are for delta wound motors. Consult factory for wye-wound motor specifications.



### I FORCE

- Ironless motor, patented, RE34674
- Cross-section: 2.25”H (57.1mm) x 1.25”W (31.7mm)
- Peak forces in four sizes to 110lbs (494), continuous forces to 24.8lb (104.5N)
- Precision ground 3-piece track (210 model)
- Two lengths of modular magnet tracks allow unlimited length of travel
- Prealigned imbedded digital HEDs, also available in separate cable from motor leads
- Internal air cooling manifold standard
- Internal thermal cutout switch protects coil

### PERFORMANCE

MOTOR MODEL		210-1	210-2	210-3	210-4
Peak Force	N	137.0	255.8	375.0	494.2
	lb	30.8	57.5	84.3	111.1
Continuous Force	N	30.7	57.4	84.1	110.3
	lb	6.9	12.9	18.9	24.8
Peak Power	W	905	1583	2261	2940
Continuous Power	W	45	79	113	147

### ELECTRICAL

MOTOR MODEL		210-1			210-2			210-3			210-4		
WIRING TYPE	UNITS	S-Series	P-Parallel	T-Triple	S-Series	P-Parallel	T-Triple	S-Series	P-Parallel	T-Triple	S-Series	P-Parallel	T-Triple
Peak Current	A <sub>pk sine</sub>	12.6	25.2	37.8	11.8	23.6	35.4	11.5	23	34.5	11.3	22.6	33.9
	(RMS)	8.9	17.8	26.7	8.3	16.7	25.0	8.1	16.3	24.4	8.0	16.0	23.9
Continuous Current	A <sub>pk sine</sub>	2.8	5.6	8.4	2.6	5.2	7.8	2.6	5.2	7.8	2.5	5.0	7.5
	(RMS)	1.9	3.9	5.9	1.8	3.7	5.5	1.8	3.7	5.5	1.8	3.5	5.3
Force Constant	N/A peak	10.9	5.4	3.6	21.8	10.9	7.3	32.7	16.4	10.9	43.6	21.8	14.5
	lb/A peak	2.5	1.2	0.8	4.9	2.5	1.6	7.4	3.7	2.5	9.8	4.9	3.3
Back EMF	V/m/s	12.6	6.3	4.2	25.2	12.6	8.4	37.8	18.9	12.6	50.4	25.2	16.8
	V/in/s	0.32	0.16	0.11	0.64	0.32	0.21	0.96	0.48	0.32	1.28	0.64	0.43
Resistance 25°C, phase to phase	ohms	5.9	1.5	0.7	11.8	3.0	1.3	17.7	4.4	2.0	23.6	5.9	2.6
Inductance, phase to phase	mH	2.4	0.6	0.3	4.8	1.2	0.5	7.2	1.8	0.8	9.6	2.4	1.1
Electrical Time Constant	ms	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Motor Constant	N/W	4.54	4.54	4.54	6.45	6.45	6.45	7.87	7.87	7.87	9.12	9.12	9.12
	lb/W	1.02	1.02	1.02	1.45	1.45	1.45	1.77	1.77	1.77	2.05	2.05	2.05
Max Terminal Voltage	VDC	330	330	330	330	330	330	330	330	330	330	330	330

### THERMAL

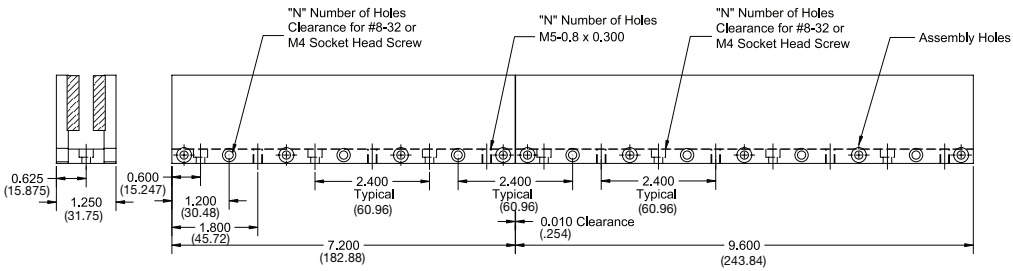
MOTOR MODEL		210-1	210-2	210-3	210-4
Thermal Resistance Wind-Amb	degC / W	1.67	0.94	0.66	0.51
Thermal Time Constant	min	4.3	4.3	4.3	4.3
Maximum Winding Temperature	°C	100	100	100	100

### MECHANICAL

MOTOR MODEL		210-1	210-2	210-3	210-4
Coil Weight	kg	0.16	0.27	0.39	0.51
	lb	0.35	0.60	0.86	1.12
Coil Length	mm	81.3	142.2	203.2	264.2
	in	3.2	5.6	8.0	10.4
Attractive Force	N	0	0	0	0
	lbf	0	0	0	0
Electrical Cycle Length	mm	60.96	60.96	60.96	60.96
	in	2.4	2.4	2.4	2.4

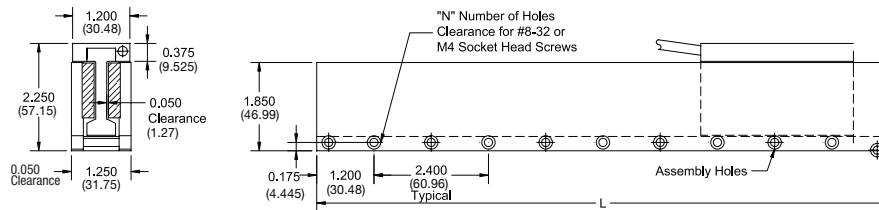


**MODULAR**  
21007M  
21009M



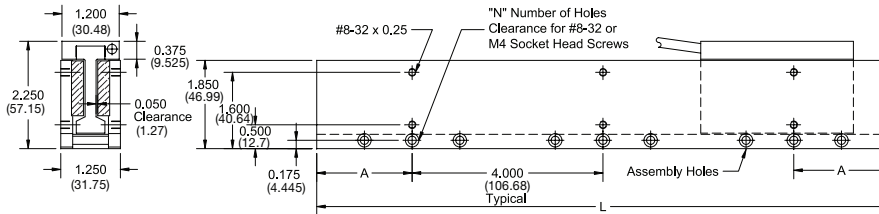
**Incremental Length:**  
2.4in/60.96mm  
**Minimum Length:**  
2.4in/60.96mm  
**Maximum Length:**  
**(For Single Piece)**  
48in/1219.2mm  
**Weight/Foot:**  
5.50lbs/ft

**MODULAR**  
210xxM1



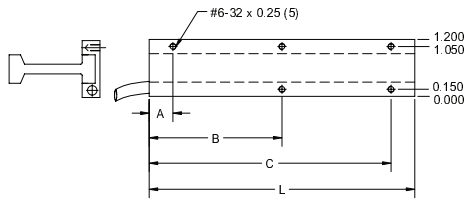
**Incremental Length:**  
2.4in/60.96mm  
**Minimum Length:**  
2.4in/60.96mm  
**Maximum Length:**  
48in/1219.2mm  
**Weight/Foot:**  
5.50lbs/ft

**SINGLE PIECE**  
210xxS

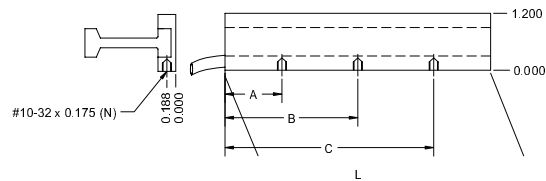


**Incremental Length:**  
1.2in/30.48mm  
**Minimum Length:**  
8.4in/213.4mm  
**Maximum Length:**  
48in/1219.2mm  
**Weight/Foot:**  
5.50lbs/ft

**(A) ENGLISH TOP MOUNTING**



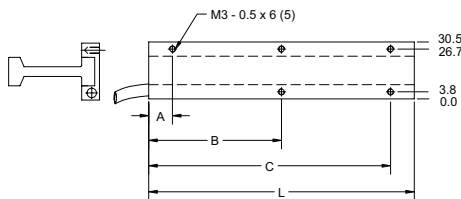
**(B) ENGLISH SIDE MOUNTING**



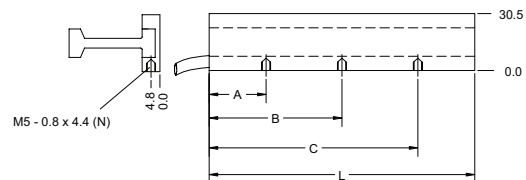
COIL SIZE (inches)	L	N	A	B	C
210-1A	3.20	5	0.50	1.60	2.70
210-2A	5.60	5	0.50	2.80	5.10
210-3A	8.00	5	0.50	4.00	7.50
210-4A	10.40	5	0.50	5.20	9.90

COIL SIZE (inches)	L	N	A	B	C
210-1B	3.20	2	1.950	2.950	---
210-2B	5.60	2	1.625	3.975	---
210-3B	8.00	3	2.438	4.000	5.562
210-4B	10.40	3	2.600	5.200	7.800

**(M) METRIC TOP MOUNTING**



**(N) METRIC SIDE MOUNTING**



COIL SIZE (mm)	L	N	A	B	C
210-1M	81.3	5	12.7	40.6	68.6
210-2M	142.2	5	12.7	71.1	129.5
210-3M	203.2	5	12.7	101.6	190.5
210-4M	264.2	5	12.7	132.1	251.5

COIL SIZE (mm)	L	N	A	B	C
210-1N	81.3	2	49.5	74.9	---
210-2N	142.2	2	41.3	101.0	---
210-3N	203.2	3	61.9	101.6	141.3
210-4N	264.2	3	66.0	132.1	198.1

### MODULAR TRACK COMBINATIONS

LENGTH In Inches	LENGTH In mm	QUANTITY 21007M	QUANTITY 21009M
7.2	182.9	1	0
9.6	243.8	0	1
12.0	304.8	0	0
14.4	365.8	2	0
16.8	426.7	1	1
19.2	487.7	0	2
21.6	548.6	3	0
24.0	609.6	2	1
26.4	670.6	1	2
28.8	731.5	0	3
31.2	792.5	3	1
33.6	853.4	2	2
36.0	914.4	1	3
38.4	975.4	0	4
40.8	1036.3	3	2
43.2	1097.3	2	3
45.6	1158.3	1	4
48.0	1219.2	0	5
50.4	1280.2	3	3
52.8	1341.1	2	4
55.2	1402.1	1	5
57.6	1463.0	0	6
60.0	1524.0	3	4
62.4	1585.0	2	5
64.8	1645.9	1	6
67.2	1706.9	0	7
69.6	1767.8	3	5
72.0	1828.8	2	6

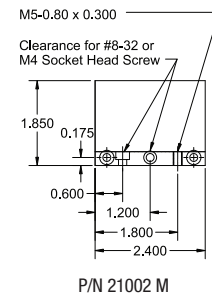
\*Please note that 72.0 inches is NOT the maximum length for modular tracks.

### 210xxS SINGLE PIECE

P/N	210xx	S	L (in)	L (mm)	A	mm	N
21008	S	8.4	205.8	0.20	5.08	3	
21009	S	9.6	235.2	0.80	20.32	3	
21010	S	10.8	264.6	1.40	35.56	3	
21012	S	12.0	294.0	2.00	50.80	3	
21013	S	13.2	323.4	2.60	66.04	3	
21014	S	14.4	352.8	3.20	81.28	3	
21015	S	15.6	382.2	3.80	96.52	3	
21016	S	16.8	411.6	0.40	10.16	5	
21018	S	18.0	441.0	1.00	25.40	5	
21019	S	19.2	470.4	1.60	40.64	5	
21020	S	20.4	499.8	2.20	55.88	5	
21021	S	21.6	529.2	2.80	71.12	5	
21022	S	22.8	558.6	3.40	86.36	5	
21024	S	24.0	588.0	4.00	101.60	5	
21025	S	25.2	614.4	0.60	15.24	7	
21026	S	26.4	646.8	1.20	30.48	7	
21027	S	27.6	676.2	1.80	45.72	7	
21028	S	28.8	705.6	2.40	60.96	7	
21030	S	30.0	735.0	3.00	76.20	7	
21031	S	31.2	764.4	3.60	91.44	7	
21032	S	32.4	793.8	0.20	5.08	9	
21033	S	33.6	823.2	0.80	20.32	9	
21034	S	34.8	842.6	1.40	35.56	9	
21036	S	36.0	882.0	2.00	50.80	9	
21037	S	37.2	911.4	2.60	66.04	9	
21038	S	38.4	940.8	3.20	81.28	9	
21039	S	39.6	970.2	3.80	96.52	9	
21040	S	40.8	999.6	0.40	10.16	11	
21042	S	42.0	1029.0	1.00	25.40	11	
21043	S	43.2	1058.4	1.60	40.64	11	
21044	S	44.4	1127.8	2.20	55.88	11	
21045	S	45.6	1158.2	2.80	71.12	11	
21046	S	46.8	1188.7	3.40	86.36	11	
21048	S	48.0	1219.2	4.00	101.6	11	

### 210xxM AND 210xxM1 MODULAR

P/N	210xx	M/M1	L (in)	L (mm)	N
21002	M/M1	2.4	60.96	1	
21004	M/M1	4.8	121.62	2	
21007	M/M1	7.2	182.88	3	
21009	M/M1	9.6	243.84	4	
21012	M/M1	12.0	304.80	5	
21014	M/M1	14.4	365.76	6	
21016	M/M1	16.8	426.72	7	
21019	M/M1	19.2	487.68	8	
21021	M/M1	21.6	548.64	9	
21024	M/M1	24.0	609.60	10	
21026	M/M1	26.4	670.56	11	
21028	M/M1	28.8	731.52	12	
21031	M/M1	31.2	792.48	13	
21033	M/M1	33.6	853.44	14	
21036	M/M1	36.0	914.40	15	
21038	M/M1	38.4	975.36	16	
21040	M/M1	40.8	1036.32	17	
21043	M/M1	43.2	1097.28	18	
21045	M/M1	45.6	1158.24	19	
21048	M/M1	48.0	1219.20	20	

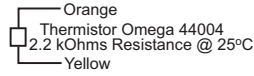
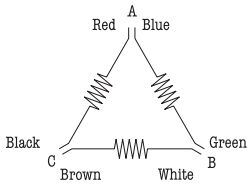






**WD1**

Delta wound with Thermistor  
Single Cable: THF08

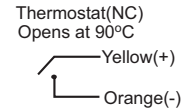
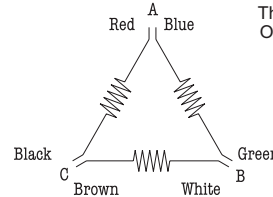


$$\frac{1}{T} = A + B(\text{LOG}_e R) + C(\text{LOG}_e R)^3$$

Where T = °Kelvin; R = Resistance; A, B, C = fitting constants  
A=1.4626 E-3 B=2.4024 E-4 C=8.0353 E-8

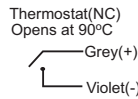
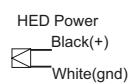
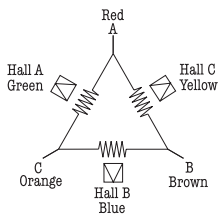
**WD2**

Delta wound with Thermostat  
Single Cable: THF08



**WD3**

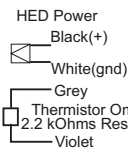
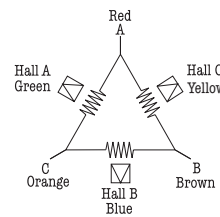
Delta wound with Thermostat  
Digital Hall Effect Devices  
Single Cable: THF10



**Hall Effect Devices**  
Symmetrical Response  
4.5V to 18 V Operation  
Open Collector Output  
I<sub>OUT</sub> Continuous 15 mA

**WD4**

Delta wound with Thermistor  
Digital Hall Effect Devices  
Single Cable: THF10



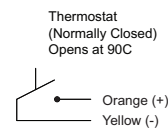
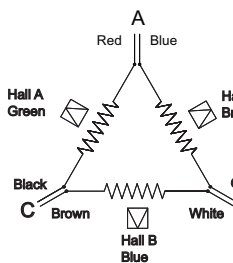
**Hall Effect Devices**  
Symmetrical Response  
4.5V to 18 V Operation  
Open Collector Output  
I<sub>OUT</sub> Continuous 15 mA

$$\frac{1}{T} = A + B(\text{LOG}_e R) + C(\text{LOG}_e R)^3$$

Where T = °Kelvin; R = Resistance; A, B, C = fitting constants  
A=1.4626 E-3 B=2.4024 E-4 C=8.0353 E-8

**WD7\***

Delta wound with Thermostat  
Digital Hall Effect Devices  
Dual Cables: THF06 and THF08



**HALL EFFECT DEVICES**  
Symmetrical Response  
4.5 to 18 Vdc power  
Open Collector Output  
15ma continuous

\*Preferred Configuration with Parker Drives

**NOTES**

1. Peak force and current based on 5% duty cycle and one second duration.
2. Continuous force and current based on coil winding temperature maintained at 100°C.
3. Force constant is peak of resistive force produced by 1.0 amp thru one motor lead and 0.5 amps thru other two leads. Also, Back EMF (V/in/sec) \* 7.665 = Force constant (lb/amp).
4. Motor resistance measured between any two motor leads with motor connected in Delta winding at 25°C. For temperature at 100°C, multiply resistance by 1.295 (75°C rise \* 0.393%/°C).
5. Back EMF measured between any two motor leads while moving at constant velocity. Value is amplitude or 0-Peak of sine wave produced.
6. Motor inductance measured using 1Kz with the motor in the magnetic field.
7. Electrical Time Constant is time it takes for motor value to reach 63% of its final current after a step change in voltage.
8. Thermal Time Constant is time it takes for motor temperature to reach 63% of its final value after a step change in power.
9. Thermal Resistance is the number of degrees (Celsius) of temperature rise in the winding per watt of power dissipated. Determined experimentally.
10. Motor Constant is a measure of efficiency. Calculated by dividing the force constant by the square root of the motor resistance at maximum operating temperature.
11. Electrical Cycle Length is distance coil must travel to complete 360° electrical cycle.
12. Use TIPS sizing software for the most accurate estimate of coil temperature for a particular motion profile.
13. Motors available with nickel plating or black epoxy coating on magnets. Track part number modified with -N or -B at end. Must be specified at time of order.
14. Electrical motor specifications are for delta wound motors. Consult factory for wye-wound motor specifications.



### I-FORCE

- Ironless motor, patented, RE34674
- Cross-section: 3.40”H (86.4mm) x 1.35”W (34.3mm)
- Peak forces in two sizes to 263lbs (1170N), continuous forces to 58lbs (262N)
- Precision ground 3-piece track (310 model)
- Two lengths of modular magnet tracks allow unlimited length of travel
- Single-piece magnet tracks to 66” length
- Prealigned embedded digital HEDs, also available in separate cable from motor leads
- Internal air or liquid cooling available
- Internal thermal cutout switch protects coil

### PERFORMANCE

MOTOR MODEL		310-1	310-2	310-3	310-4	310-5	310-6
Peak Force	N	218.9	409.3	600.0	790.0	980.0	1170.0
	lb	49.2	92.0	135.1	177.2	220.3	263.2
Continuous Force	N	49.0	91.6	133.9	176.2	219.3	262.0
	lb	11.0	20.6	30.1	39.6	49.3	58.9
Peak Power	W	1077	1885	2693	3500	4308	5116
Continuous Power	W	54	94	135	179	215	256

### ELECTRICAL

MOTOR MODEL		310-1			310-2			310-3			310-4			310-5			310-6		
WIRING TYPE	UNITS	S	P	T	S	P	T	S	P	T	S	P	T	S	P	T	S	P	T
Peak Current	A pk sine	16.1	32.2	48.3	15.0	30.0	45.0	14.7	29.4	44.1	14.5	29.0	43.5	14.4	28.8	43.2	14.3	28.6	42.9
	(RMS)	11.4	22.8	34.2	10.6	21.2	31.8	10.4	20.8	31.2	10.3	20.5	30.8	10.2	20.4	30.5	10.1	20.2	30.3
Continuous Current	A pk sine	3.6	7.2	10.8	3.4	6.8	10.2	3.3	6.6	9.9	3.2	6.4	9.6	3.2	6.4	9.6	3.2	6.4	9.6
	(RMS)	2.5	5.1	7.6	2.4	4.8	7.2	2.5	4.7	7.0	2.3	4.5	6.8	2.3	4.5	6.8	2.3	4.5	6.8
Force Constant	N/A peak	13.7	6.8	4.6	27.3	13.6	9.1	40.9	20.5	13.6	54.7	27.4	18.2	68.1	34.0	22.7	81.8	40.9	27.3
	lb/A peak	3.1	1.5	1.0	6.1	3.1	2.0	9.2	4.6	3.1	12.3	6.2	4.1	15.3	7.7	5.1	18.4	9.2	6.1
Back EMF	V/m/s	15.7	7.8	5.2	31.5	15.7	10.5	47.2	23.6	15.7	63.0	31.5	21.0	78.7	39.4	26.2	94.5	47.2	31.5
	V/in/s	0.40	0.20	0.13	0.80	0.40	0.27	1.20	0.60	0.40	1.60	0.80	0.53	2.00	1.00	0.67	2.40	1.20	0.80
Resistance 25°C, phase to phase	ohms	4.3	1.1	0.5	8.6	2.2	1.0	12.9	3.2	1.4	17.2	4.3	1.9	21.5	5.4	2.4	25.8	6.5	2.9
Inductance, phase to phase	mH	3.0	0.8	0.3	6.0	1.5	0.7	9.0	2.3	1.0	12.0	3.0	1.3	15.0	3.8	1.7	18.0	4.5	2.0
Electrical Time Constant	ms	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Motor Constant	N/W	6.67	6.67	6.67	9.43	9.43	9.43	11.57	11.57	11.57	13.34	13.34	13.34	14.95	14.95	14.95	16.37	16.37	16.37
	lb/W	1.50	1.50	1.50	2.12	2.12	2.12	2.60	2.60	2.60	3.00	3.00	3.00	3.36	3.36	3.36	3.68	3.68	3.68
Max Terminal Voltage	VDC	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330

NOTE: S-Series P-Parallel T-Triple

### THERMAL

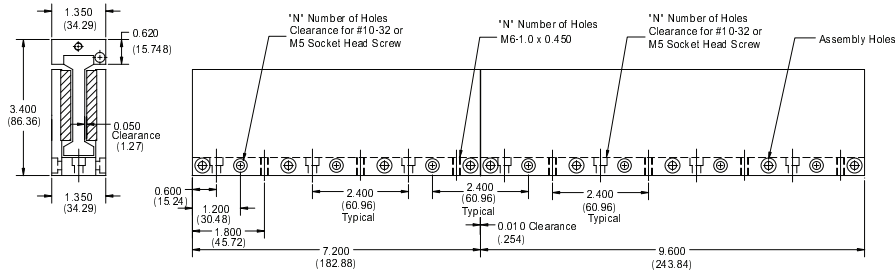
MOTOR MODEL		310-1	310-2	310-3	310-4	310-5	310-6
Thermal Resistance Wind-Amb	degC / W	1.39	0.79	0.56	0.43	0.35	0.29
Thermal Time Constant	min	7.5	7.5	7.5	7.5	7.5	7.5
Maximum Winding Temperature	°C	100	100	100	100	100	100

### MECHANICAL

MOTOR MODEL		310-1	310-2	310-3	310-4	310-5	310-6
Coil Weight	kg	0.31	0.55	0.80	1.03	1.27	1.53
	lb	0.69	1.22	1.75	2.27	2.80	3.36
Coil Length	mm	81.3	142.2	203.2	264.2	325.1	386.1
	in	3.2	5.6	8.0	10.4	12.8	15.2
Attractive Force	N	0	0	0	0	0	0
	lbf	0	0	0	0	0	0
Electrical Cycle Length	mm	60.96	60.96	60.96	60.96	60.96	60.96
	in	2.4	2.4	2.4	2.4	2.4	2.4



## MODULAR 31007M 31009M



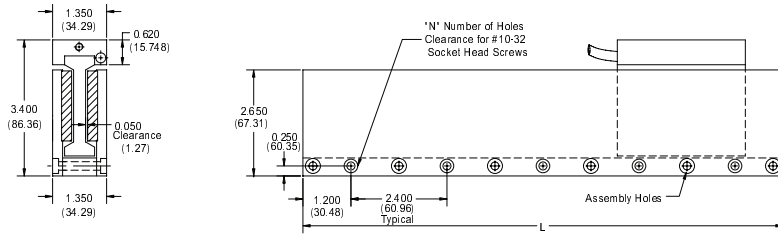
**Incremental Length:**  
2.4in/60.96mm

**Minimum Length:**  
2.4in/60.96mm

**Maximum Length:  
(For Single Piece)**  
64.8in/1645.9mm

**Weight/Foot:**  
8.50lbs/ft

## MODULAR 310xxM1



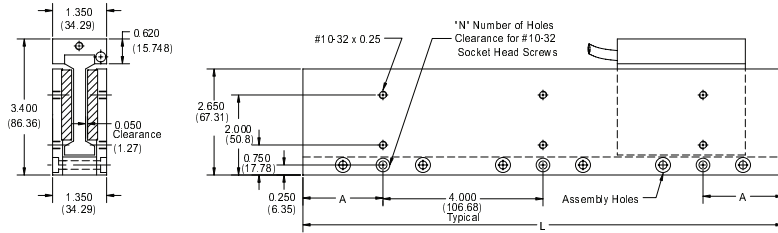
**Incremental Length:**  
2.4in/60.96mm

**Minimum Length:**  
2.4in/60.96mm

**Maximum Length:**  
64.8in/1645.9mm

**Weight/Foot:**  
8.50lbs/ft

## SINGLE PIECE 310xxS



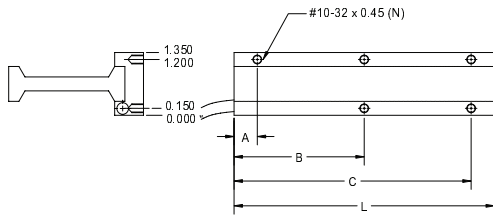
**Incremental Length:**  
1.2in/30.48mm

**Minimum Length:**  
8.4in/213.4mm

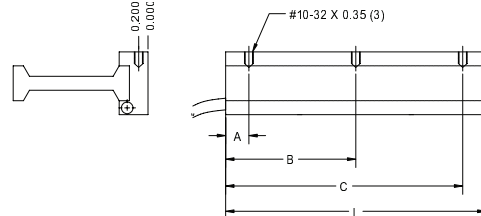
**Maximum Length:**  
66in/1676.4mm

**Weight/Foot:**  
8.50lbs/ft

### (A) ENGLISH TOP MOUNTING



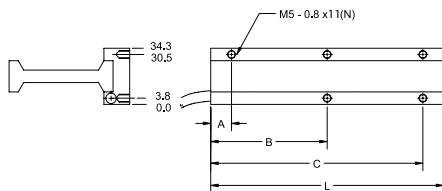
### (B) ENGLISH SIDE MOUNTING



COIL SIZE (inches)	L	N	A	B	C
310-1A	3.20	4	0.50	1.60	2.70
310-2A	5.60	5	0.50	2.80	5.10
310-3A	8.00	5	0.50	4.00	7.50
310-4A	10.40	5	0.50	5.20	9.90
310-5A	12.80	5	0.50	6.40	12.30
310-6A	15.20	5	1.70	7.60	13.50

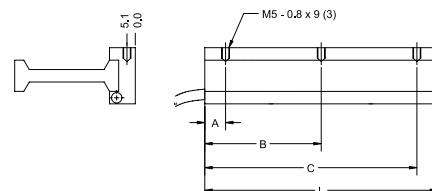
COIL SIZE (inches)	L	N	A	B	C
310-1B	3.20	3	0.50	1.60	2.70
310-2B	5.60	3	0.50	2.80	5.10
310-3B	8.00	3	0.50	4.00	7.50
310-4B	10.40	3	0.50	5.20	9.90
310-5B	12.80	3	0.50	6.40	12.30
310-6B	15.20	3	1.70	7.60	13.50

### (M) METRIC TOP MOUNTING



COIL SIZE (mm)	L	N	A	B	C
310-1M	81.3	4	12.7	40.6	68.6
310-2M	141.2	5	12.7	71.1	129.5
310-3M	203.2	5	12.7	101.6	190.5
310-4M	264.2	5	12.7	132.1	251.5
310-5M	325.1	5	12.7	162.6	312.4
310-6M	386.1	5	43.2	193.0	342.9

### (N) METRIC SIDE MOUNTING



COIL SIZE (mm)	L	N	A	B	C
310-1N	81.3	3	12.7	40.6	68.6
310-2N	141.2	3	12.7	71.1	129.5
310-3N	203.2	3	12.7	101.6	190.5
310-4N	264.2	3	12.7	132.1	251.5
310-5N	325.1	3	12.7	162.6	312.4
310-6N	386.1	3	43.2	193.0	342.9

### MODULAR TRACK COMBINATIONS

LENGTH In Inches	LENGTH In mm	QUANTITY 31007M	QUANTITY 31009M
7.2	182.9	1	0
9.6	243.8	0	1
12.0	304.8	1	0
14.4	365.8	2	0
16.8	426.7	1	1
19.2	487.7	0	2
21.6	548.6	3	0
24.0	609.6	2	1
26.4	670.6	1	2
28.8	731.5	0	3
31.2	792.5	3	1
33.6	853.4	2	2
36.0	914.4	1	3
38.4	975.4	0	4
40.8	1036.3	3	2
43.2	1097.3	2	3
45.6	1158.3	1	4
48.0	1219.2	0	5
50.4	1280.2	3	3
52.8	1341.1	2	4
55.2	1402.1	1	5
57.6	1463.0	0	6
60.0	1524.0	3	4
62.4	1585.0	2	5
64.8	1645.9	1	6
67.2	1706.9	0	7
69.6	1767.8	3	5
72.0	1828.8	2	6

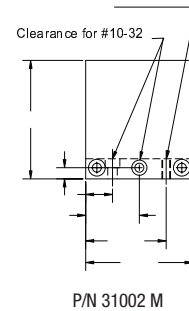
\*Please note that 72.0 inches is NOT the maximum length for modular tracks.

### 310xxS SINGLE PIECE

P/N	310xx	S	L (in)	L (mm)	A	A (mm)	N	P/N	310xx	S	L (in)	L (mm)	A	A (mm)	N
31008	S		8.4	205.8	0.20	5.08	3	31038	S		38.4	940.8	3.20	81.28	9
31009	S		9.6	235.2	0.80	20.32	3	31039	S		39.6	970.2	3.80	96.52	9
31010	S		10.8	264.6	1.40	1.40	3	31040	S		40.8	999.6	0.40	10.16	11
31012	S		12.0	294.0	2.00	50.80	3	31042	S		42.0	1029.0	1.00	25.40	11
31013	S		13.2	323.4	2.60	66.04	3	31043	S		43.2	1058.4	1.60	40.64	11
31014	S		14.4	352.8	3.20	81.28	3	31044	S		44.4	1087.8	2.20	55.88	11
31015	S		15.6	382.2	3.80	96.52	3	31045	S		45.6	1117.2	2.80	71.12	11
31016	S		16.8	411.6	0.40	10.16	5	31046	S		46.8	1146.6	3.40	86.36	11
31018	S		18.0	441.0	1.00	25.40	5	31048	S		48.0	1176.0	4.00	101.60	11
31019	S		19.2	470.4	1.60	40.64	5	31049	S		49.2	1205.4	0.60	15.24	13
31020	S		20.4	499.8	2.20	55.88	5	31050	S		50.4	1234.8	1.20	30.48	13
31021	S		21.6	529.2	2.80	71.12	5	31051	S		51.6	1264.2	1.80	45.72	13
31022	S		22.8	558.6	3.40	86.36	5	31052	S		52.8	1293.6	2.40	60.96	13
31024	S		24.0	588.0	4.00	101.60	5	31054	S		54.0	1323.0	3.00	76.20	13
31025	S		25.2	617.4	0.60	15.24	7	31055	S		55.2	1352.4	3.60	91.44	13
31026	S		26.4	646.8	1.20	30.48	7	31056	S		56.4	1381.8	0.20	5.08	15
31027	S		27.6	676.2	1.80	45.72	7	31057	S		57.6	1411.2	0.80	20.32	15
31028	S		28.8	705.6	2.40	60.96	7	31058	S		58.8	1440.6	1.40	35.56	15
31030	S		30.0	735.0	3.00	76.20	7	31060	S		60.0	1470.0	2.00	50.80	15
31031	S		31.2	764.4	3.60	91.44	7	31061	S		61.2	1499.4	2.60	66.04	15
31032	S		32.4	793.8	0.20	5.08	9	31062	S		62.4	1528.8	3.20	81.28	15
31033	S		33.6	823.2	0.80	20.32	9	31063	S		63.6	1558.2	3.80	96.52	15
31034	S		34.8	852.6	1.40	35.56	9	31064	S		64.8	1587.6	0.40	10.16	17
31036	S		36.0	882.0	2.00	50.80	9	31066	S		66.0	1617.0	1.00	25.40	17
31037	S		37.2	911.4	2.60	66.04	9								

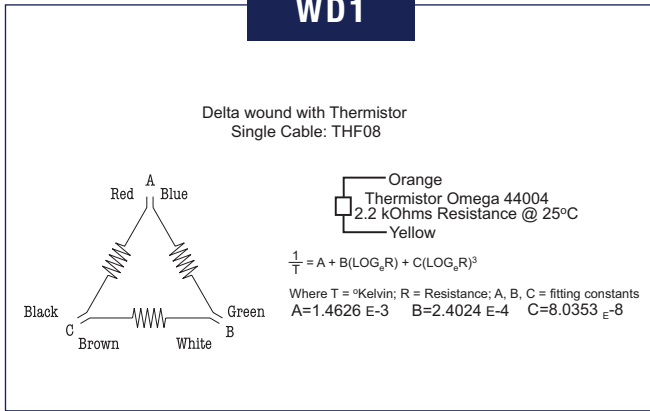
### 310xxM AND 310xxM1 MODULAR

P/N	310xx	M1	L (in)	L (mm)	N	P/N	310xx	M/M1	L (in)	L (mm)	N
31002	M/M1		2.4	60.96	1	31028	M/M1		28.8	731.52	12
31004	M/M1		4.8	121.92	2	31031	M/M1		31.2	792.48	13
31007	M/M1		7.2	182.88	3	31033	M/M1		33.6	853.44	14
31009	M/M1		9.6	243.84	4	31036	M/M1		36.0	914.40	15
31012	M/M1		12.0	304.80	5	31038	M/M1		38.1	975.36	16
31014	M/M1		14.4	365.76	6	31040	M/M1		40.8	1036.32	17
31016	M/M1		16.8	426.72	7	31043	M/M1		43.2	1097.28	18
31019	M/M1		19.2	487.68	8	31045	M/M1		45.6	1158.20	19
31021	M/M1		21.6	548.64	9	31048	M/M1		48.0	1219.20	20
31024	M/M1		24.0	609.60	10	31050	M/M1		50.4	1280.16	21
31026	M/M1		26.4	670.56	11	31052	M/M1		52.8	1341.12	22
						31055	M/M1		55.2	1402.08	23
						31057	M/M1		57.6	1463.04	24
						31060	M/M1		60.0	1524.00	25
						31062	M/M1		62.4	1584.96	26
						31064	M/M1		64.8	1645.92	27

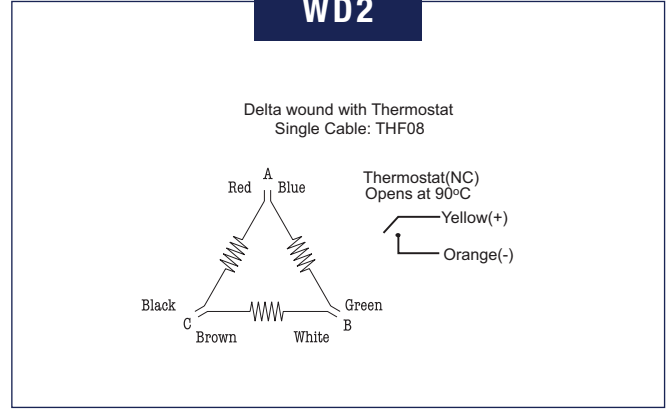




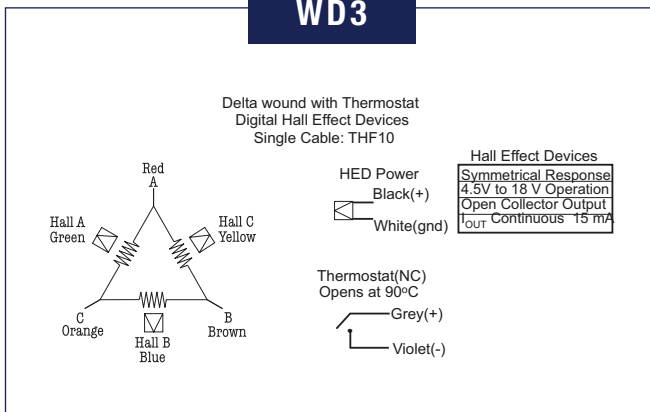
**WD1**



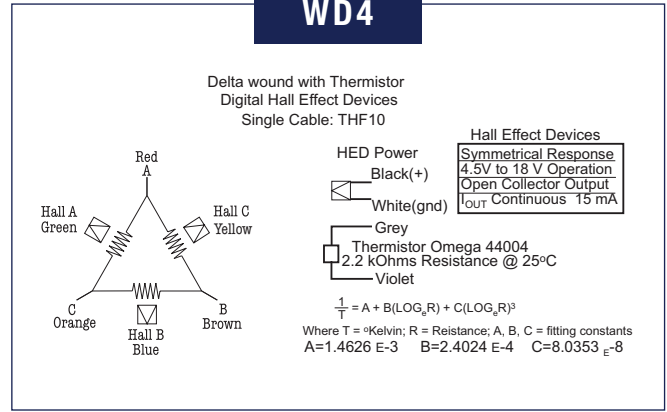
**WD2**



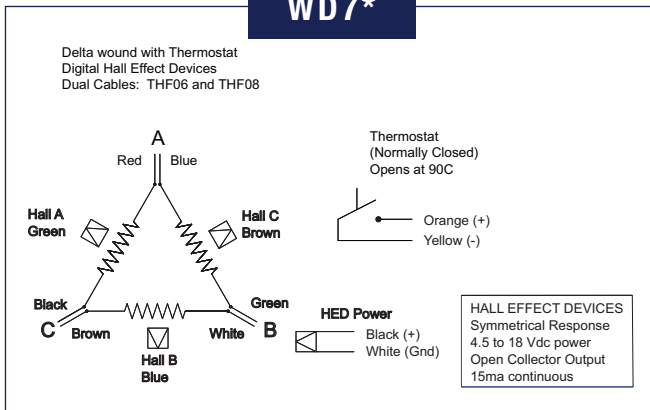
**WD3**



**WD4**



**WD7\***



\*Preferred Configuration with Parker Drives

**NOTES**

1. Peak force and current based on 5% duty cycle and one second duration.
2. Continuous force and current based on coil winding temperature maintained at 100°C.
3. Force constant is peak of resistive force produced by 1.0 amp thru one motor lead and 0.5 amps thru other two leads. Also, Back EMF (V/in/Sec) \* 7.665 = Force constant (lb/amp).
4. Motor resistance measured between any two motor leads with motor connected in Delta winding at 25°C. For temperature at 100°C, multiply resistance by 1.295 (75°C rise \* 0.393%/°C)
5. Back EMF measured between any two motor leads while moving at constant velocity. Value is amplitude or 0-Peak of sine wave produced.
6. Motor inductance measured using 1Kz with the motor in the magnetic field.
7. Electrical Time Constant is time it takes for motor value to reach 63% of its final current after a step change in voltage.
8. Thermal Time Constant is time it takes for motor temperature to reach 63% of its final value after a step change in power.
9. Thermal Resistance is the number of degrees (Celsius) of temperature rise in the winding per watt of power dissipated. Determined experimentally.
10. Motor Constant is a measure of efficiency. Calculated by dividing the force constant by the square root of the motor resistance at maximum operating temperature.
11. Electrical Cycle Length is distance coil must travel to complete 360° electrical cycle.
12. Use TIPS sizing software for the most accurate estimate of coil temperature for a particular motion profile.
13. Motors available with nickel plating or black epoxy coating on magnets. Track part number modified with -N or -B at end. Must be specified at time of order.
14. Electrical motor specifications are for delta wound motors. Consult factory for wye-wound motor specifications.





### I-FORCE

- Ironless motor, patented, RE34674
- Cross-section: 4.50”H (114.3mm) x 2.00”W (50.8mm)
- Peak forces in two sizes to 883lbs (3928N), continuous forces to 197 lbs (878N)
- Precision ground 3-piece track (410 model)
- Two lengths of modular magnet tracks allow unlimited length of travel
- Single-piece magnet tracks to 72.24” length
- Prealigned embedded digital HEDs, also available in separate cable from motor leads
- Internal air cooling manifold or liquid cooling manifold
- Internal thermal cutout switch protects coil

### PERFORMANCE

MOTOR MODEL		410-2	410-3	410-4	410-6	410-8
Peak Force	N	1041.4	1523.6	2006.3	2967.2	3928.1
	lb	234.1	342.5	451.0	667.0	883.0
Continuous Force	N	233.1	340.8	448.9	663.7	878.6
	lb	52.4	76.6	100.9	149.2	197.5
Peak Power	W	2835	4050	5265	7695	10125
Continuous Power	W	142	203	263	385	506

### ELECTRICAL

MOTOR MODEL		410-2			410-3			410-4			410-6			410-8		
WIRING TYPE	UNITS	S	P	T	S	P	T	S	P	T	S	P	T	S	P	T
Peak Current	A <sup>pk sine</sup>	19.1	38.2	57.3	18.6	37.2	55.8	18.4	36.8	55.2	18.1	36.2	54.3	18.0	36.0	54.0
	(RMS)	13.5	27.0	40.5	13.2	23.6	39.5	13.0	26.0	39.0	12.8	25.6	38.4	12.7	25.5	38.2
Continuous Current	A <sup>pk sine</sup>	4.3	8.6	12.9	4.2	8.4	12.6	4.1	8.2	12.3	4.1	8.2	12.3	4.0	8.0	12.0
	(RMS)	3.0	6.1	9.1	3.0	5.9	8.9	2.9	5.8	8.7	2.9	5.8	8.7	2.8	5.7	8.5
Force Constant	N/A peak	54.5	27.3	18.2	81.8	40.9	27.3	109.0	54.5	36.3	163.7	81.8	54.6	218.4	109.2	72.8
	lb/A peak	12.3	6.1	4.1	18.4	9.2	6.1	24.5	12.3	8.2	36.8	18.4	12.3	49.1	24.6	16.4
Back EMF V/in/s	V/m/s	63.0	31.5	21.0	94.5	47.2	31.5	126.0	63.0	42.0	189.0	94.5	63.0	252.0	126.0	84.0
		1.60	0.80	0.53	2.40	1.20	0.80	3.20	1.60	1.07	4.80	2.40	1.60	6.40	3.20	2.13
Resistance 25°C, phase to phase	ohms	8.0	2.0	0.9	12.0	3.0	1.3	16.0	4.0	1.8	24.0	6.0	2.7	32.0	8.0	3.6
Inductance, phase to phase	mH	10.0	2.5	1.1	15.0	3.8	1.7	20.0	5.0	2.2	30.0	7.5	3.3	40.0	10.0	4.4
Electrical Time Constant	ms	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor Constant	N/W	19.57	19.57	19.57	23.98	23.98	23.98	27.67	27.67	27.67	33.90	33.90	33.90	39.14	39.14	39.14
	lb/W	4.40	4.40	4.40	5.39	5.39	5.39	6.22	6.22	6.22	7.62	7.62	7.62	8.80	8.80	8.80
Max Terminal Voltage	VDC	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330

NOTE: S-Series P-Parallel T-Triple

### THERMAL

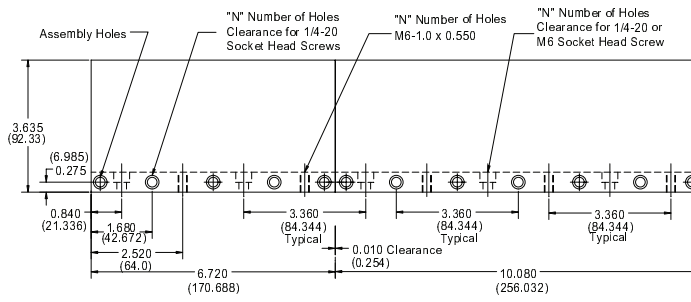
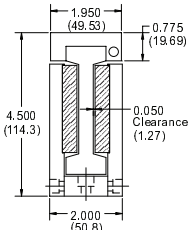
MOTOR MODEL		410-2	410-3	410-4	410-6	410-8
Thermal Resistance Wind-Amb	degC / W	0.53	0.37	0.26	0.19	0.15
Thermal Time Constant	min	15.1	15.1	15.1	15.1	15.1
Maximum Winding Temperature	°C	100	100	100	100	100

### MECHANICAL

MOTOR MODEL		410-2	410-3	410-4	410-6	410-8
Coil Weight	kg	1.59	2.27	2.95	4.32	5.68
	lb	3.5	5.0	6.5	9.5	12.5
Coil Length	mm	199.1	284.5	369.8	540.5	711.2
	in	7.84	11.20	14.56	21.28	28.00
Attractive Force	N	0	0	0	0	0
	lbf	0	0	0	0	0
Electrical Cycle Length	mm	85.34	85.34	85.34	85.34	85.34
	in	3.36	3.36	3.36	3.36	3.36



**MODULAR  
41006M  
41010M**



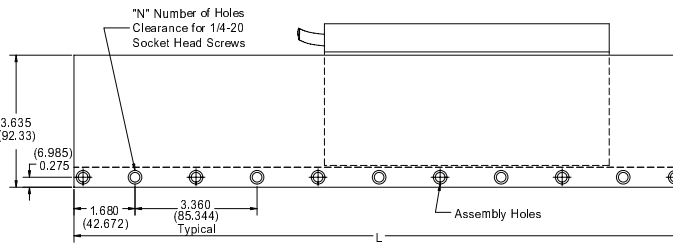
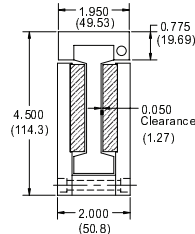
**Incremental Length:**  
3.36in/85.34mm

**Minimum Length:**  
6.72in/170.7mm

**Maximum Length:**  
70.56in/1792.22mm

**Weight/Foot:**  
20.0lbs/ft

**MODULAR  
410xxM1**



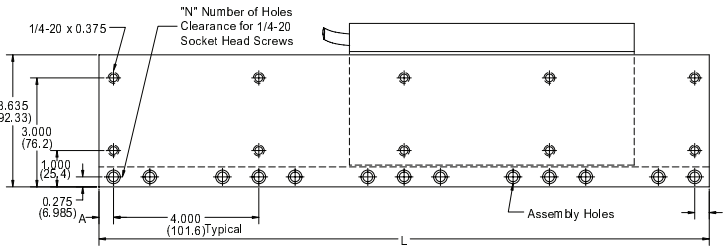
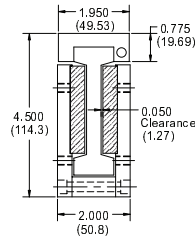
**Incremental Length:**  
3.36in/85.34mm

**Minimum Length:**  
6.72in/170.7mm

**Maximum Length:**  
70.56in/1792.22mm

**Weight/Foot:**  
20.0lbs/ft

**SINGLE PIECE  
410xxS**



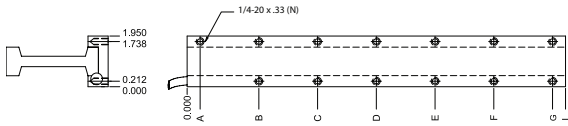
**Incremental Length:**  
1.68in/42.67mm

**Minimum Length:**  
16.80in/426.72mm

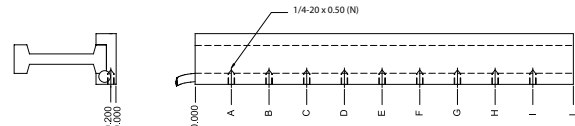
**Maximum Length:**  
72.24in/1834.9mm

**Weight/Foot:**  
20.0lbs/ft

**(A) ENGLISH TOP MOUNTING**



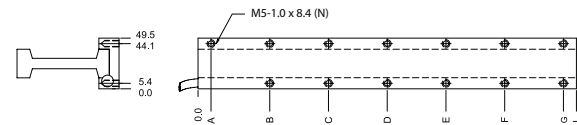
**(B) ENGLISH SIDE MOUNTING**



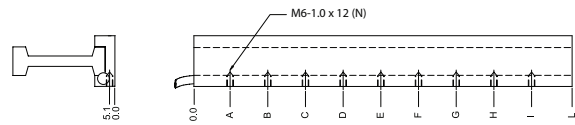
COIL SIZE (in)	L	N	A	B	C	D	E	F	G
410-2A	7.84	5	0.50	3.92	7.34	---	---	---	---
410-3A	11.20	8	0.50	1.60	5.60	9.60	10.70	---	---
410-4A	14.56	9	0.50	3.28	7.28	11.28	14.06	---	---
410-6A	21.28	13	0.50	2.64	6.64	10.64	14.64	18.64	20.78
410-8A	28.00	13	2.00	6.00	10.00	14.00	18.00	22.00	26.00

COIL SIZE (in)	L	N	A	B	C	D	E	F	G	H	I
410-2B	7.84	3	2.90	4.90	6.90	---	---	---	---	---	---
410-3B	11.20	3	4.10	7.10	10.10	---	---	---	---	---	---
410-4B	14.56	4	2.78	5.78	8.78	11.78	---	---	---	---	---
410-6B	21.28	6	3.14	6.14	9.14	12.14	15.14	18.14	---	---	---
410-8B	28.00	9	3.50	6.50	9.50	12.50	15.50	18.50	21.50	24.50	27.50

**(M) METRIC TOP MOUNTING**



**(N) METRIC SIDE MOUNTING**



COIL SIZE (mm)	L	N	A	B	C	D	E	F	G
410-2M	199.1	5	12.7	99.6	186.4	---	---	---	---
410-3M	284.5	8	12.7	40.6	142.2	243.8	271.8	---	---
410-4M	369.8	9	12.7	83.3	184.9	286.5	357.1	---	---
410-6M	540.5	13	12.7	67.1	168.7	270.3	371.9	473.4	527.8
410-8M	711.2	13	50.8	152.4	254.0	355.6	457.2	558.8	660.4

COIL SIZE (mm)	L	N	A	B	C	D	E	F	G	H	I
410-2N	199.1	3	73.7	124.5	175.3	---	---	---	---	---	---
410-3N	284.5	3	104.1	180.3	256.5	---	---	---	---	---	---
410-4N	369.8	4	70.6	146.8	223.0	299.2	---	---	---	---	---
410-6N	540.5	6	79.7	156.0	232.2	308.4	384.6	460.8	---	---	---
410-8N	711.2	9	88.9	165.1	241.3	317.5	393.7	469.9	546.1	622.3	698.5



**MODULAR TRACK COMBINATIONS**

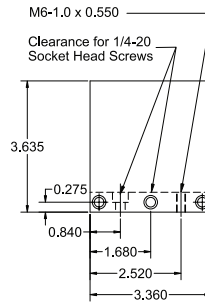
LENGTH Inches	LENGTH In mm	QUANTITY 41006M	QUANTITY 41010M
6.72	170.69	1	0
10.08	256.03	0	1
13.44	341.38	0	0
16.80	426.72	1	1
20.16	512.06	0	2
23.52	597.41	2	1
26.88	682.75	1	2
30.24	768.10	0	3
33.60	853.44	2	2
36.96	938.78	1	3
40.32	1024.13	0	4
43.68	1109.47	2	3
47.04	1194.82	1	4
50.40	1280.16	0	5
53.76	1365.50	2	4
57.12	1450.85	1	5
60.48	1536.19	0	6
63.84	1621.54	2	5
67.20	1706.88	1	6
70.56	1792.22	0	7
73.92	1877.57	2	6
77.28	1962.91	1	7
80.64	2048.26	0	8
84.00	2133.60	2	7
87.36	2218.94	1	8
90.72	2304.29	0	9
94.08	2389.63	2	8
97.44	2474.98	1	9

**410 xxM AND 410 xxM1 MODULAR**

P/N	410xx M/M1	L (in)	L (mm)	N
41006	M/M1	6.72	170.69	2
41010	M/M1	10.08	256.03	3
41013	M/M1	13.44	341.38	4
41016	M/M1	16.80	426.72	5
41020	M/M1	20.16	512.06	6
41023	M/M1	23.52	597.41	7
41026	M/M1	26.88	682.75	8
41030	M/M1	30.24	768.10	9
41033	M/M1	33.60	853.44	10
41036	M/M1	36.96	938.78	11
41040	M/M1	40.32	1024.13	12
41043	M/M1	43.68	1109.47	13
41047	M/M1	47.04	1194.82	14
41050	M/M1	50.40	1280.16	15
41053	M/M1	53.76	1365.50	16
41057	M/M1	57.12	1450.85	17
41060	M/M1	60.48	1536.19	18
41063	M/M1	63.84	1621.54	19
41067	M/M1	67.20	1706.88	20
41070	M/M1	70.56	1792.22	21

**410xxS SINGLE PIECE**

P/N	410xx S	L	A	N
41016	S	16.80	1.68	5
41018	S	18.48	2.52	5
41020	S	20.16	3.36	5
41021	S	21.84	0.84	7
41023	S	23.52	1.68	7
41025	S	25.20	2.52	7
41026	S	26.88	3.36	7
41028	S	28.56	0.84	9
41030	S	30.24	1.68	9
41031	S	31.92	2.52	9
41033	S	33.60	3.36	9
41035	S	35.28	0.84	11
41036	S	36.96	1.68	11
41038	S	38.64	2.53	11
41040	S	40.32	3.36	11
41042	S	42.00	0.84	13
41043	S	43.68	1.68	13
41045	S	45.36	2.52	13
41047	S	47.04	3.36	13
41048	S	48.72	0.84	15
41050	S	50.40	1.68	15
41052	S	52.08	2.52	15
41053	S	53.76	3.36	15
41055	S	55.44	0.84	17
41057	S	57.12	1.68	17
41058	S	58.80	2.52	17
41060	S	60.48	3.36	17
41062	S	62.16	0.84	19
41063	S	63.84	1.68	19
41065	S	65.52	2.52	19
41067	S	67.20	3.36	19
41068	S	68.88	0.84	21
41070	S	70.56	1.68	21
41072	S	72.24	2.52	21



P/N 41003 M

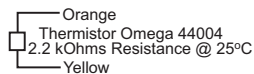
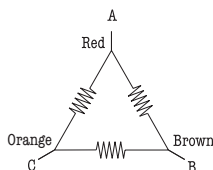






**WD1**

Delta wound with Thermistor  
Single Cable: THF05

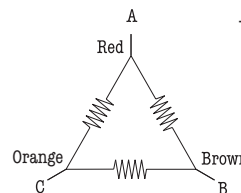


$$\frac{1}{T} = A + B(\text{LOG}_e R) + C(\text{LOG}_e R)^2$$

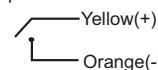
Where T = °Kelvin; R = Resistance; A, B, C = fitting constants  
A=1.4626 E-3 B=2.4024 E-4 C=8.0353 E-8

**WD2**

Delta wound with Thermostat  
Single Cable: THF05

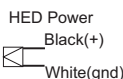
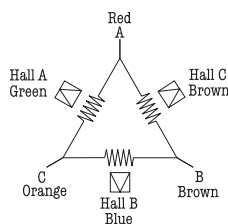


Thermostat(NC)  
Opens at 90°C

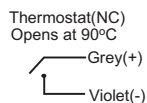


**WD3**

Delta wound with Thermostat  
Digital Hall Effect Devices  
Dual Cable: THF05 and THF06

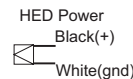
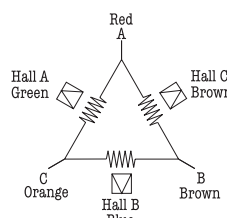


Hall Effect Devices  
Symmetrical Response  
4.5V to 18 V Operation  
Open Collector Output  
I<sub>OUT</sub> Continuous 15 mA



**WD4**

Delta wound with Thermistor  
Digital Hall Effect Devices  
Dual Cable: THF05 and THF06



Hall Effect Devices  
Symmetrical Response  
4.5V to 18 V Operation  
Open Collector Output  
I<sub>OUT</sub> Continuous 15 mA



$$\frac{1}{T} = A + B(\text{LOG}_e R) + C(\text{LOG}_e R)^2$$

Where T = °Kelvin; R = Resistance; A, B, C = fitting constants  
A=1.4626 E-3 B=2.4024 E-4 C=8.0353 E-8

**NOTES**

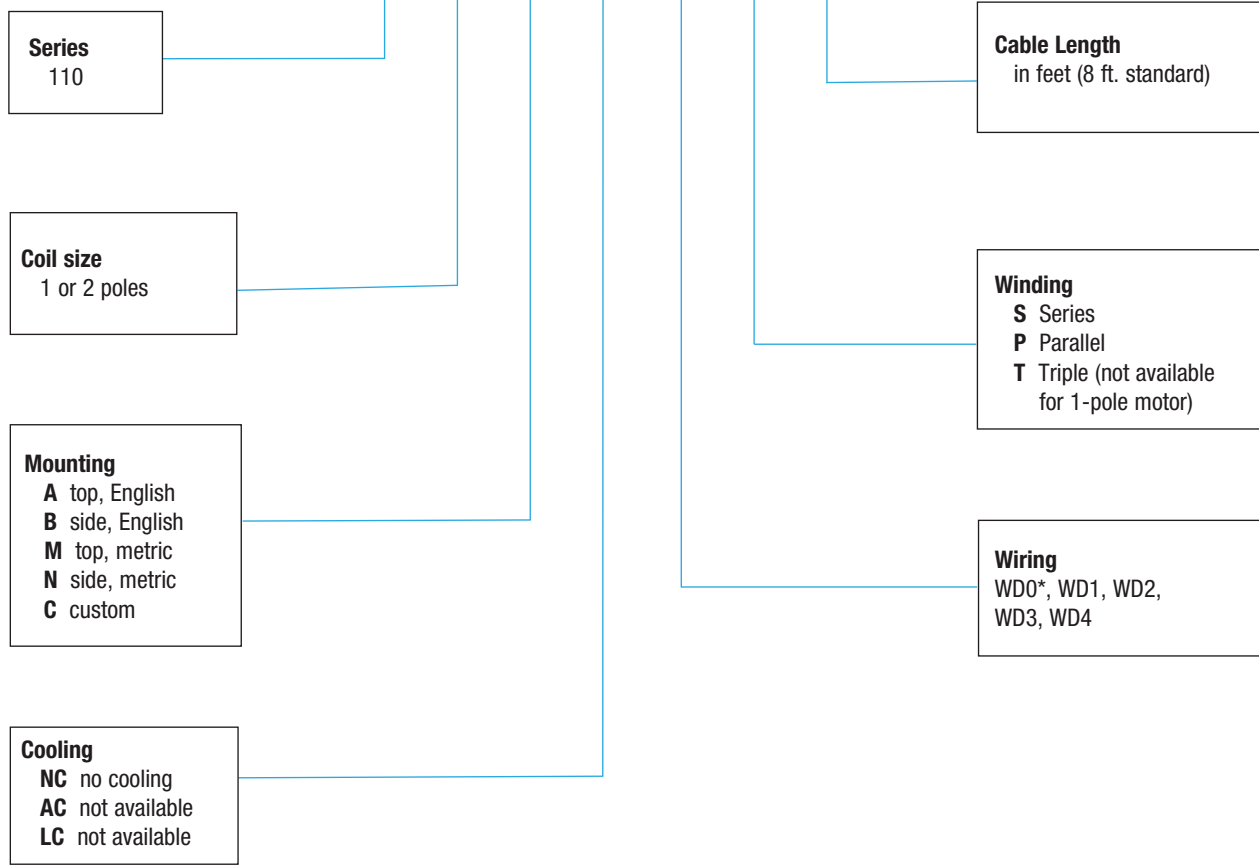
1. Peak force and current based on 5% duty cycle and one second duration.
2. Continuous force and current based on coil winding temperature maintained at 100°C.
3. Force constant is peak of resistive force produced by 1.0 amp thru one motor lead and 0.5 amps thru other two leads. Also, Back EMF (V/in/sec) \* 7.665 = Force constant (lb/amp).
4. Motor resistance measured between any two motor leads with motor connected in Delta winding at 25°C.  
For temperature at 100°C, multiply resistance by 1.295 (75°C rise \* 0.393%/°C)
5. Back EMF measured between any two motor leads while moving at constant velocity. Value is amplitude or 0-Peak of sine wave produced.
6. Motor inductance measured using 1Kz with the motor in the magnetic field.
7. Electrical Time Constant is time it takes for motor value to reach 63% of its final current after a step change in voltage.

8. Thermal Time Constant is time it takes for motor temperature to reach 63% of its final value after a step change in power.
9. Thermal Resistance is the number of degrees (Celsius) of temperature rise in the winding per watt of power dissipated. Determined experimentally.
10. Motor Constant is a measure of efficiency. Calculated by dividing the force constant by the square root of the motor resistance at maximum operating temperature.
11. Electrical Cycle Length is distance coil must travel to complete 360° electrical cycle.
12. Use TIPS sizing software for the most accurate estimate of coil temperature for a particular motion profile.
13. Motors available with nickel plating or black epoxy coating on magnets. Track part number modified with -N or -B at end. Must be specified at time of order.
14. Electrical motor specifications are for delta wound motors. Consult factory for wye-wound motor specifications.

### Motor Coil

Order Example:

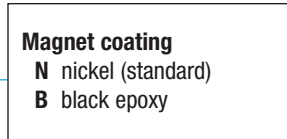
110 - 2 B - NC - WD2 P - 8



### Magnet Track:

11024M1 - N

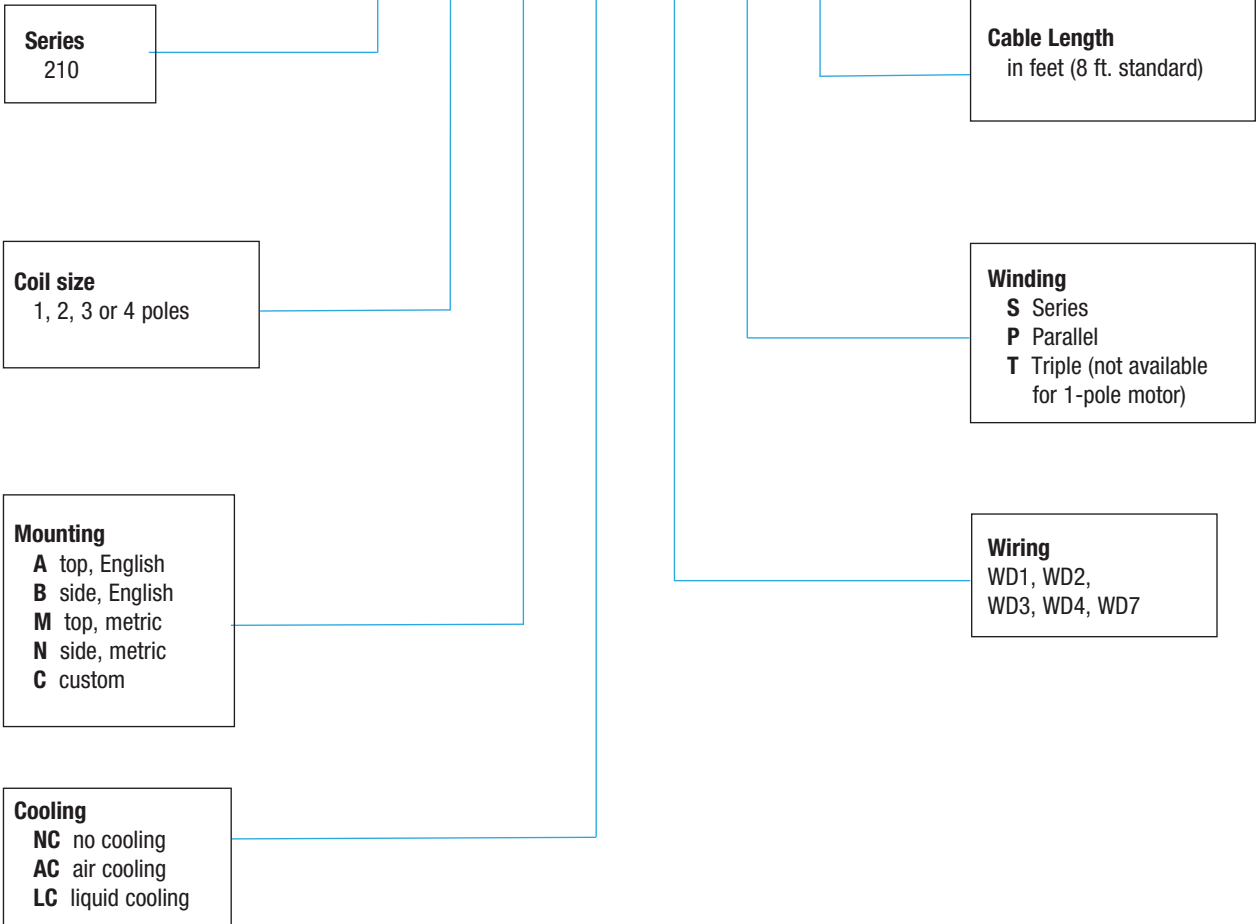
<b>110xxM:</b>	11007M, 11009M	7.20", 9.60	modular sections
<b>11507M:</b>	11507M, 11509M	7.20", 9.60	modular sections
<b>110xxM1:</b>	11036M1, max	36.00" max	single piece, 2.4" incr.
<b>110xxM:</b>	11036M, max	36.00" max	single piece, 2.4" incr.
<b>115xxM:</b>	11524M, max	24.00" max	single piece, 2.4" incr.
<b>110xxS:</b>	11036M, max	36.00" max	single piece, 1.2" incr.



### Motor Coil

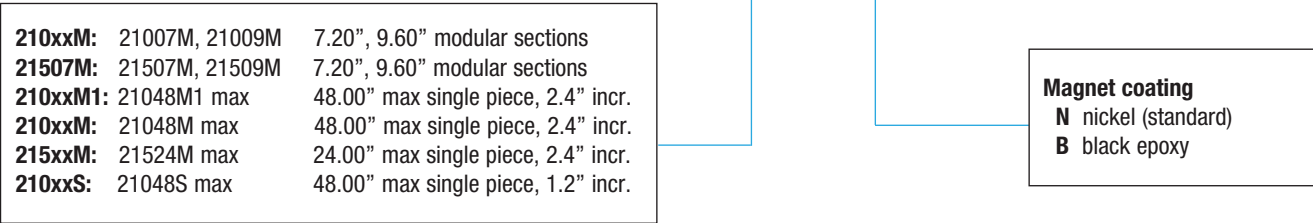
Order Example:

210 - 2 M - NC - WD2 P - 8



### Magnet Track:

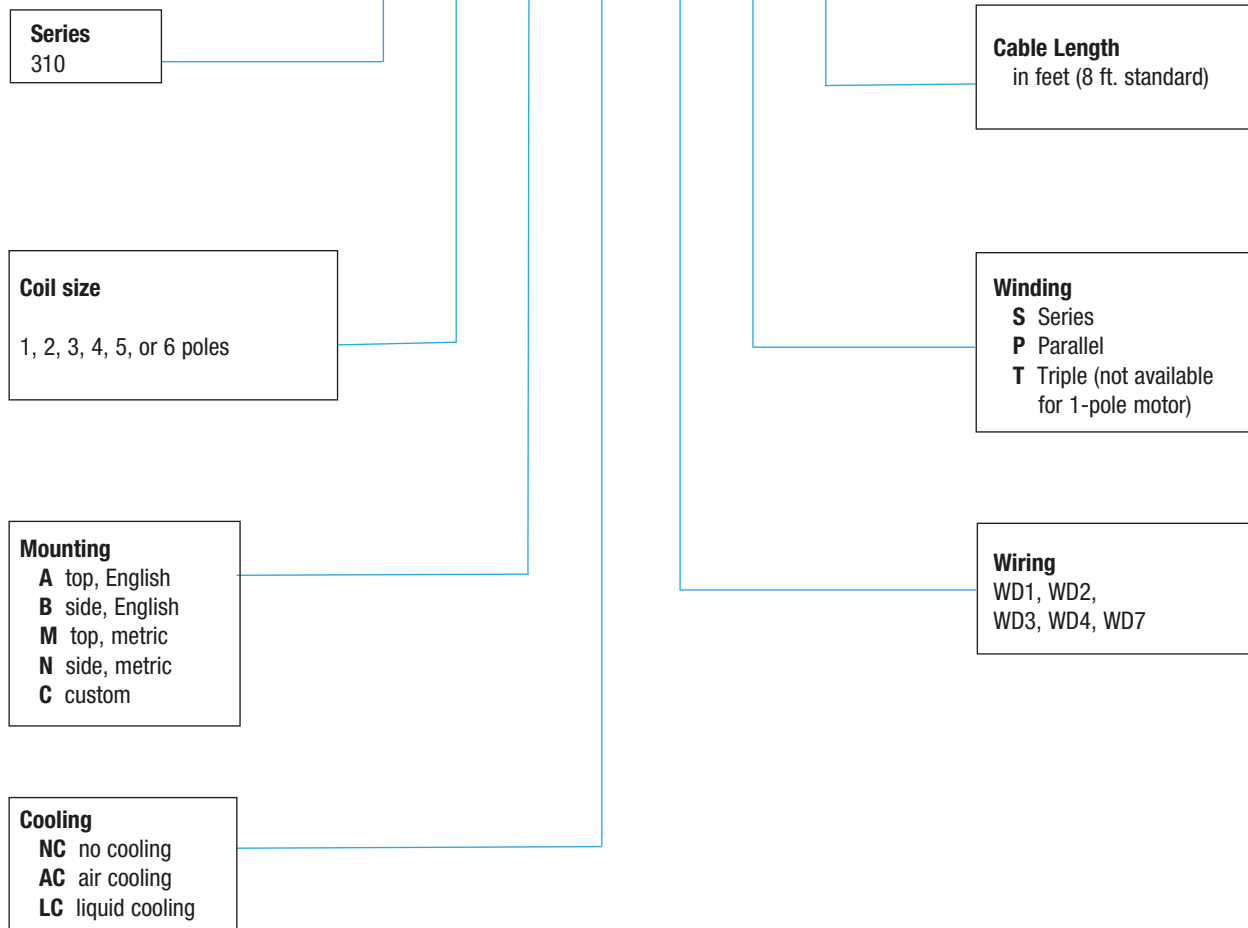
21024M1 - N



### Motor Coil

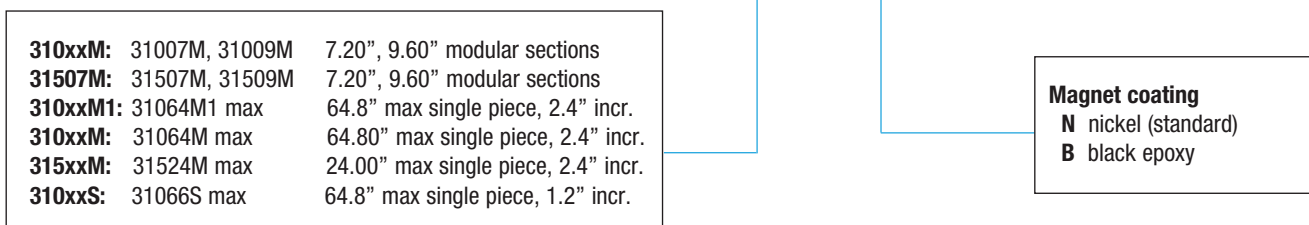
Order Example:

310 - 2 A - NC - WD2 P - 8



### Magnet Track:

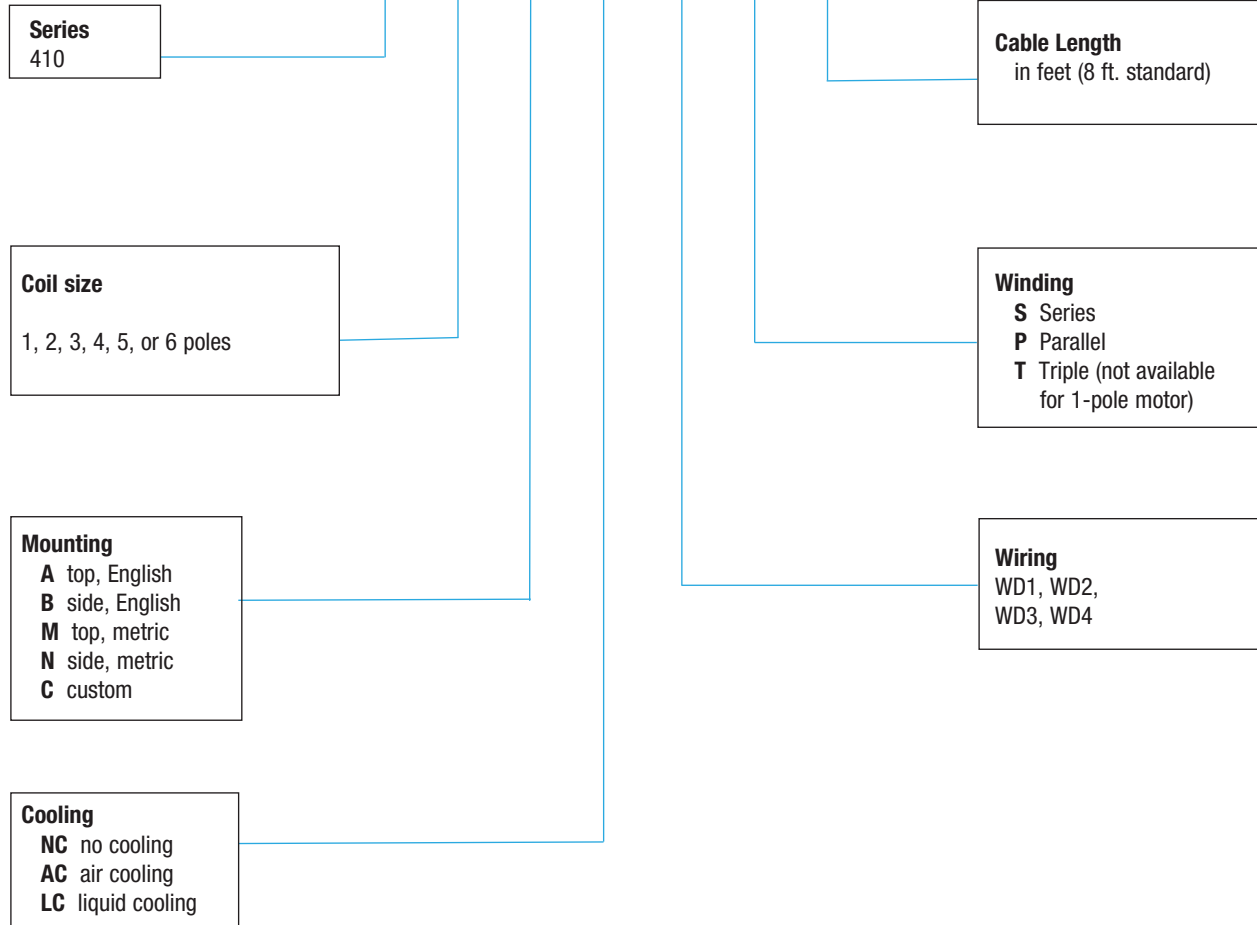
31024M1 - N



## Motor Coil

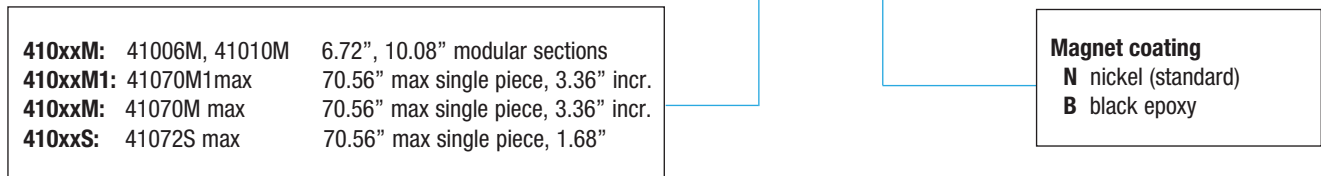
Order Example:

410 - 2 B - NC - WD2 P - 8



## Magnet Track:

41024M1 - N





**I FORCE**

- Ironless motor, patented, RE34674
- Cross-section: 155mm x 50mm
- Peak forces to 3811N (856lbs), continuous forces to 852N (191lbs)
- Precision ground 3 piece track with magnet spacers
- Two lengths of modular magnet tracks allow unlimited length of travel
- Single piece magnet tracks to 480mm
- Connector module allows quick and easy installation
- HED sensors and overtravel limits available in connector module
- Internal thermal cutout switch protects coil

**PERFORMANCE**

MOTOR MODEL		ML50-2	ML50-3	ML50-4	ML50-6	ML50-8	ML50-9
Peak Force	N	847	1270	1694	2541	3387	3811
	lbs	190.4	285.6	380.8	571.1	761.5	856.7
Continuous Force	N	189	284	379	568	757	852
	lbs	42.6	63.9	85.1	127.7	170.3	191.6
Peak Power	W	1560	2340	3120	4680	6240	7020
Continuous Power	W	78	117	156	234	312	351

**ELECTRICAL**

MOTOR MODEL		ML50-2		ML50-3		ML50-4			ML50-6			ML50-8		ML50-9	
WIRING TYPE	UNITS	S	P	S	T	S	P	D	S	P	T	P	D	T	
Peak Current	A <sub>pk sine</sub>	19.9	39.8	19.9	59.7	19.9	39.8	79.7	19.9	39.8	59.7	39.8	79.7	59.7	
	(RMS)	14.1	28.1	14.1	42.2	14.1	28.1	53.4	14.1	28.1	42.2	28.1	53.4	42.2	
Continuous Current	A <sub>pk sine</sub>	4.5	8.9	4.5	13.4	4.5	8.9	17.8	4.5	8.9	13.4	8.9	17.8	13.4	
	(RMS)	3.2	6.3	3.2	9.5	3.2	6.3	12.6	3.2	6.3	9.5	6.3	12.6	9.5	
Force Constant	N/A	42.5	21.3	63.8	21.3	85.0	42.5	21.3	127.6	63.8	42.5	85.0	42.5	63.8	
	lbs/A	9.6	4.8	14.3	4.8	19.1	9.6	4.8	28.7	14.3	9.6	19.1	9.6	14.3	
Back EMF	V/m/s	49.1	24.5	73.6	24.5	98.2	49.1	24.5	147.3	73.6	49.1	98.2	49.1	73.6	
	V/ips	1.2	0.6	1.9	0.6	2.5	1.2	0.6	3.7	1.9	1.2	2.5	1.2	1.9	
Resistance	Ohms	4.1	1.0	6.1	0.7	8.1	2.0	0.5	12.2	3.0	1.4	4.1	1.0	2.0	
Inductance	mH	3.3	0.8	5.0	0.6	6.6	1.7	0.4	9.9	2.5	1.1	3.3	0.8	1.7	
Electrical Time Constant	ms	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Motor Constant	N/√W	21.4	21.4	26.3	26.3	30.3	30.3	30.3	37.1	37.1	37.1	42.9	42.9	45.5	
	lbs/√W	4.82	4.8	5.90	5.9	6.82	6.8	6.8	8.35	8.3	8.3	9.6	9.6	10.2	
Max Terminal Voltage	VDC	330	330	330	330	330	330	330	330	330	330	330	330	330	

**THERMAL**

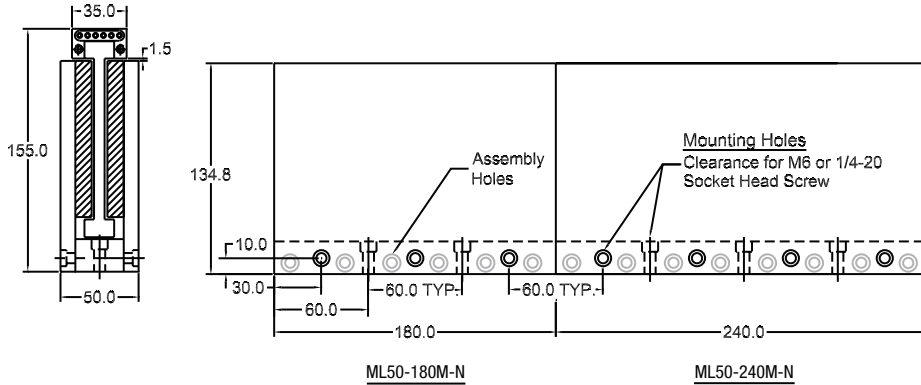
MOTOR MODEL		ML50-2	ML50-3	ML50-4	ML50-6	ML50-8	ML50-9
Thermal Resistance Wind-Amb	degC / W	0.96	0.64	0.48	0.32	0.24	0.21
Thermal Time Constant	min	9.2	9.2	9.2	9.2	9.2	9.2
Maximum Winding Temperature	degC	100	100	100	100	100	100

**MECHANIC**

MOTOR MODEL		ML50-2	ML50-3	ML50-4	ML50-6	ML50-8	ML50-9
Coil Weight	kg	0.7	1.1	1.5	2.2	2.9	3.3
	lbs	1.6	2.4	3.2	4.8	6.4	7.2
Coil Length (does not include connector module)	mm	120	180	240	360	480	540
	in	4.724	7.087	9.449	14.173	18.898	21.260
Attractive Force	N	0	0	0	0	0	0
	lbs	0	0	0	0	0	0
Electrical Cycle Length	mm	60	60	60	60	60	60



## MODULAR TRACKS ML50-180M-N ML50-240M-N



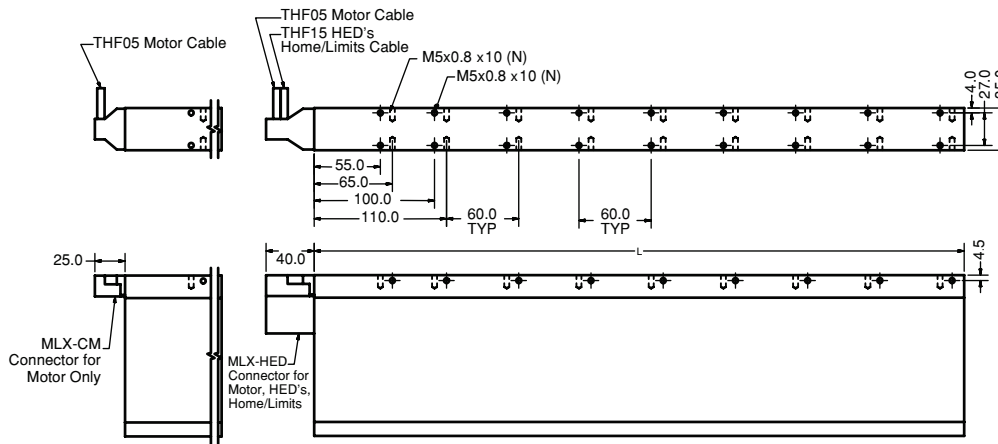
**Incremental Length:**  
60mm

**Maximum Single Piece Length:**  
480mm

**Minimum Length:**  
180mm

**Weight:**  
37.9 kg/m (25.4 lbs/ft)

## COIL ASSEMBLY ML50-xE-NC-Mx



### ML50 COIL ASSEMBLY

ML50-XE	L	N
ML50-2E	120	4
ML50-3E	180	6
ML50-4E	240	8
ML50-6E	360	12
ML50-8E	480	16
ML50-9E	540	18

### ML50 CONNECTOR MODULE

Motor connector  
Digital HEDs  
Limit sensor

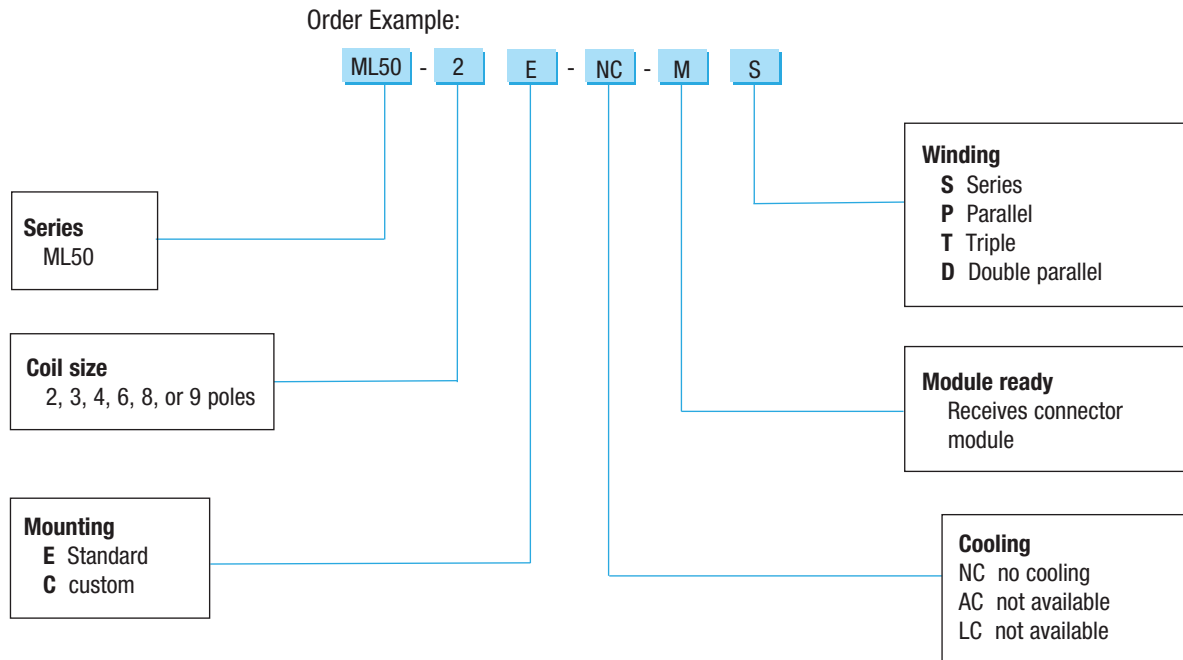
MLX-CM-R-x	●		
MLX-HED-R-x	●	●	●

x = Cable length in meters

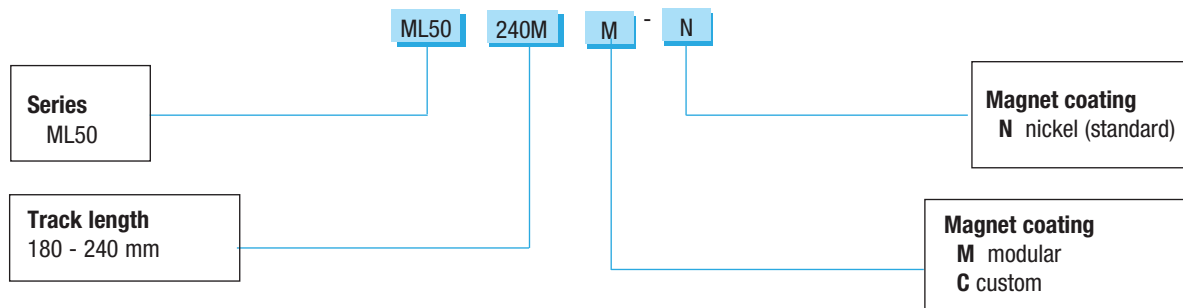
## NOTES

- Peak force and current based on 5% duty cycle and 1 sec duration.
- Continuous force and current based on coil winding temperature maintained at 100°C.
- Force constant is peak of resistive force produced by 1.0A thru one motor lead and 0.5A thru other two leads. Also,  $\text{BackEMF (V/in/sec)} * 7.665 = \text{Force constant (lb/A)}$ .
- Motor resistance measured between any two motor leads with motor connected in WYE winding at 25°C. For temperature at 100°C, multiply resistance by 1.295 (75°C rise \* 0.393%/°C)
- Back EMF measured between any two motor leads while moving at constant velocity. Value is amplitude or 0-Peak of sine wave produced.
- Motor inductance measured using 1kHz with the motor in the magnetic field.
- Electrical Time Constant is time it takes for motor current to reach 63% of it's final value after a step change in voltage.
- Thermal Time Constant is time it takes for motor temperature to reach 63% of it's final value after a step change in power.
- Thermal Resistance is the number of degrees (Celsius) of temperature rise in the winding per watt of power dissipated. Determined experimentally.
- Motor Constant is a measure of efficiency. Calculated by dividing the force constant by the square root of the motor resistance at maximum operating temperature.
- Electrical Cycle Length is distance coil must travel to complete 360° electrical cycle.
- Use TIPS sizing software for the most accurate estimate of coil temperature for a particular motion profile.

Motor Coil



Magnet Track:



Magnet Track:

