Linear Motors

I-FORCE Ironless linear motors

Parker Trilogy'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

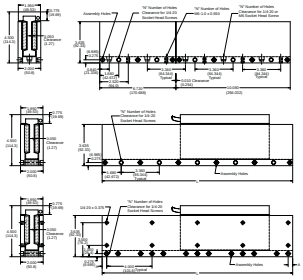
Vacuum encapsulation process:
- Allows motors to be used in high-vacuum environments (Rated at 10^-6 torr, currently used in 10^-7 torr applications)

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

110 Specifications



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

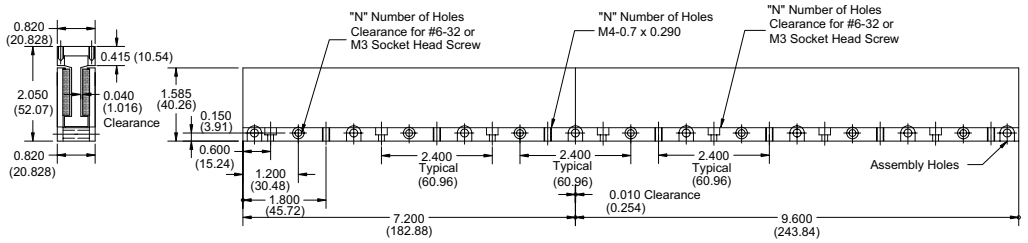
THERMAL

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



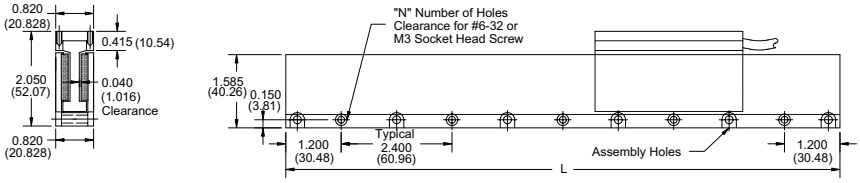
Incremental Length:
2.4in/60.96mm

Minimum Length:
2.4in/60.96mm

Maximum Length:
(For Single Piece)
36in/914.40mm

Weight/Foot:
2.66lbs/ft

MODULAR 110xxM1



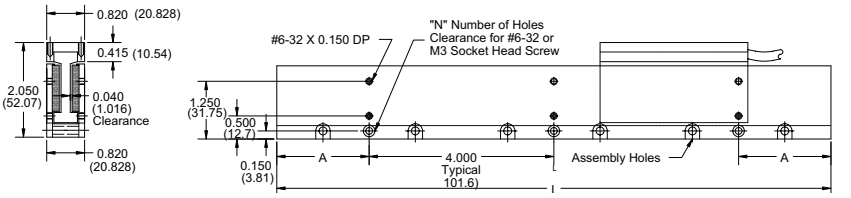
Incremental Length:
2.4in/60.96mm

Minimum Length:
2.4in/60.96mm

Maximum Length:
(For Single Piece)
36in/914.90mm

Weight/Foot:
2.66lbs/ft

SINGLE PIECE 110xxS



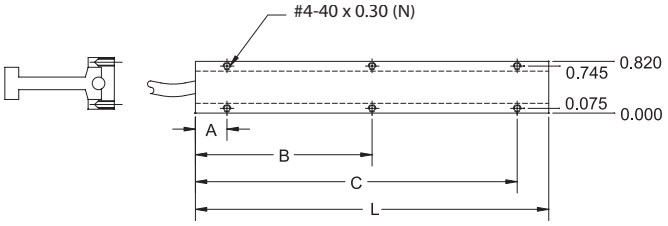
Incremental Length:
1.2in/30.48mm

Minimum Length:
8.4in/213.4mm

Maximum Length:
(For Single Piece)
36in/914.90mm

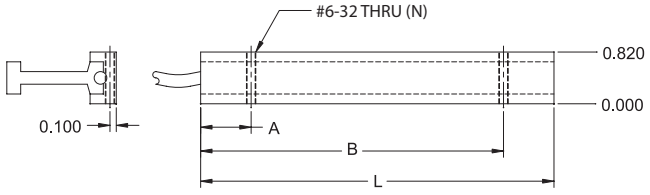
Weight/Foot:
2.66lbs/ft

(A) ENGLISH TOP MOUNTING



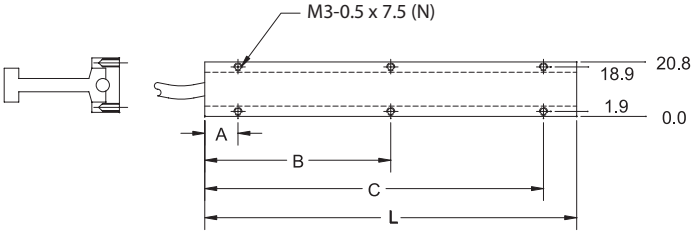
COIL SIZE (inches)	L	N	A	B	C
110-1A	3.20	4	0.50	2.70	---
110-2A	5.60	6	0.50	2.80	5.10

(B) ENGLISH SIDE MOUNTING



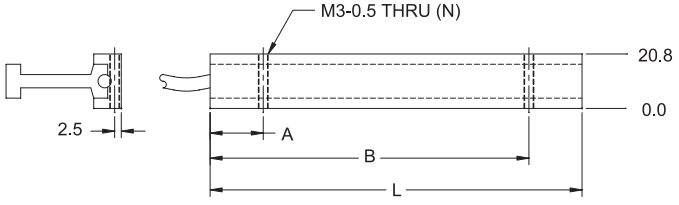
COIL SIZE (inches)	L	N	A	B
110-1B	3.20	2	0.80	2.40
110-2B	5.60	2	0.80	4.80

(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

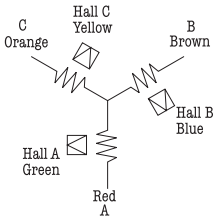
*Please note that 72.0 inches is NOT the maximum length for modular tracks.

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

WD0

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



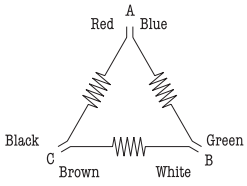
HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

Thermostat(NC)
Opens at 90ºC
Grey(+)
Violet(-)

WD1

Delta wound with Thermistor
Single Cable: THF08



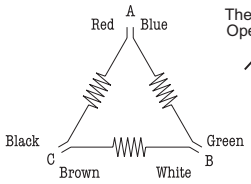
Orange
Thermistor Omega 44004
2.2 kOhms Resistance @ 25ºC
Yellow

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

Where T = ºKelvin; R = Resistance; A, B, C = fitting constants
A=1.4626 E-3 B=2.4024 E-4 C=8.0353 $_{E}$-8

WD2

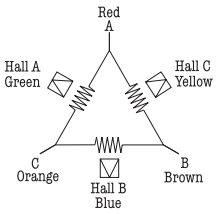
Delta wound with Thermostat
Single Cable: THF08



Thermostat(NC)
Opens at 90ºC
Yellow(+)
Orange(-)

WD3

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



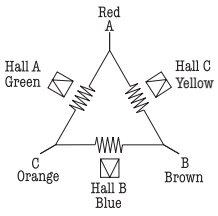
HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

Thermostat(NC)
Opens at 90ºC
Grey(+)
Violet(-)

WD4

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



HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

Grey
Thermistor Omega 44004
2.2 kOhms Resistance @ 25ºC
Violet

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

Where T = ºKelvin; R = Reistance; 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 100ºC.
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 25ºC. For temperature at 100ºC, multiply resistance by 1.295 (75ºC rise * 0.393%/ºC)
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 360º 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.

210 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 pk sine	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 pk sine	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

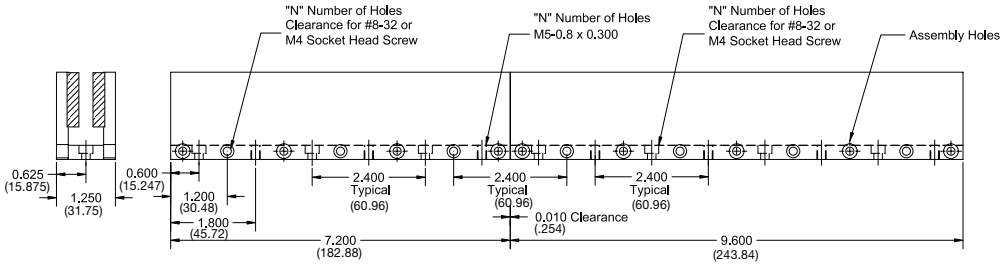
THERMAL

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



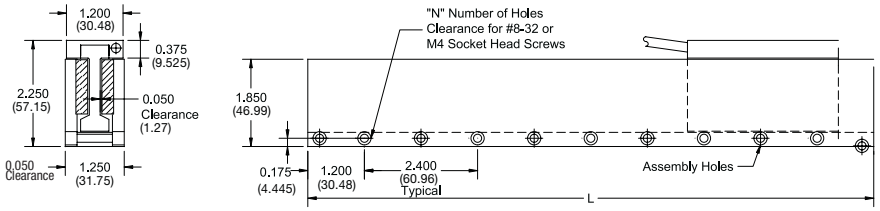
Incremental Length:
2.4in/60.96mm

Minimum Length:
2.4in/60.96mm

Maximum Length:
(For Single Piece)
48in/1219.2mm

Weight/Foot:
5.50lbs/ft

MODULAR 210xxM1



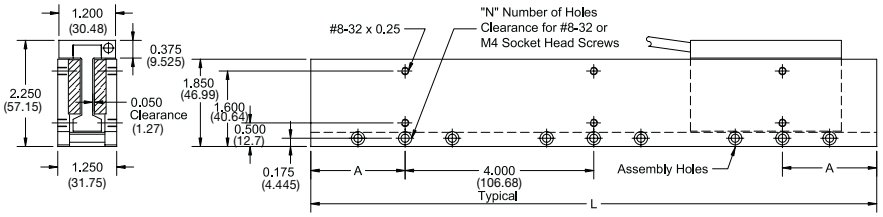
Incremental Length:
2.4in/60.96mm

Minimum Length:
2.4in/60.96mm

Maximum Length:
48in/1219.2mm

Weight/Foot:
5.50lbs/ft

SINGLE PIECE 210xxS



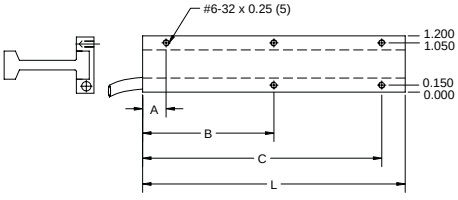
Incremental Length:
1.2in/30.48mm

Minimum Length:
8.4in/213.4mm

Maximum Length:
48in/1219.2mm

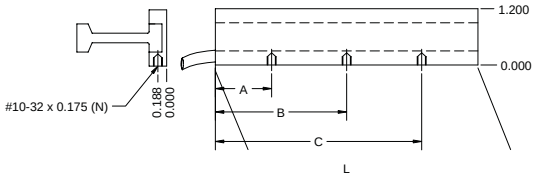
Weight/Foot:
5.50lbs/ft

(A) ENGLISH TOP MOUNTING



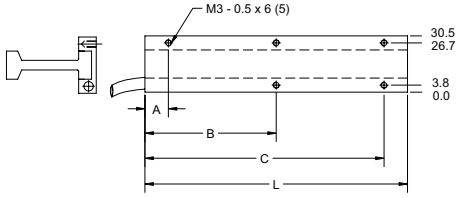
COIL SIZE (inches)	L	N	A	B	C
210-1A	3.20	5	0.50	1.60	2.70
210-2A	5.60	5	0.50	2.80	5.10
210-3A	8.00	5	0.50	4.00	7.50
210-4A	10.40	5	0.50	5.20	9.90

(B) ENGLISH SIDE MOUNTING



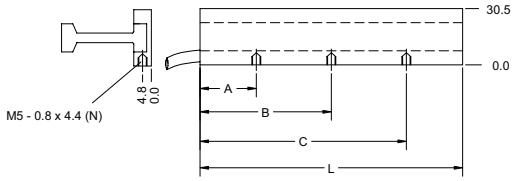
COIL SIZE (inches)	L	N	A	B	C
210-1B	3.20	2	1.950	2.950	---
210-2B	5.60	2	1.625	3.975	---
210-3B	8.00	3	2.438	4.000	5.562
210-4B	10.40	3	2.600	5.200	7.800

(M) METRIC TOP MOUNTING



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

(N) METRIC SIDE MOUNTING



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

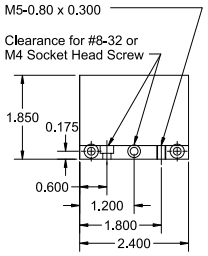
*Please note that 72.0 inches is NOT the maximum length for modular tracks.

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

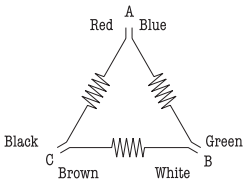
P/N	210xx	M/M1	L (in)	L (mm)	N
	21002	M/M1	2.4	60.96	1
	21004	M/M1	4.8	121.62	2
	21007	M/M1	7.2	182.88	3
	21009	M/M1	9.6	243.84	4
	21012	M/M1	12.0	304.80	5
	21014	M/M1	14.4	365.76	6
	21016	M/M1	16.8	426.72	7
	21019	M/M1	19.2	487.68	8
	21021	M/M1	21.6	548.64	9
	21024	M/M1	24.0	609.60	10
	21026	M/M1	26.4	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



P/N 21002 M

WD1

Delta wound with Thermistor
Single Cable: THF08



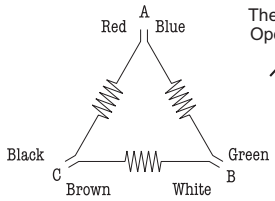
Orange
Thermistor Omega 44004
2.2 kOhms Resistance @ 25°C
Yellow

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

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

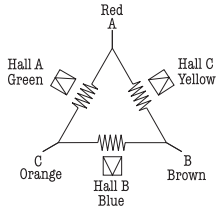
Delta wound with Thermostat
Single Cable: THF08



Thermostat(NC)
Opens at 90°C
Yellow(+)
Orange(-)

WD3

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



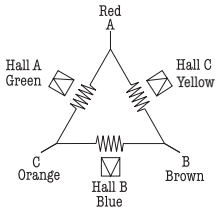
HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

Thermostat(NC)
Opens at 90°C
Grey(+)
Violet(-)

WD4

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



HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

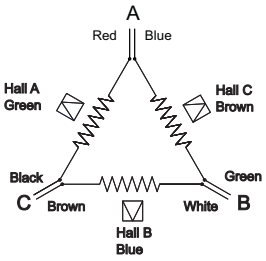
Grey
Thermistor Omega 44004
2.2 kOhms Resistance @ 25°C
Violet

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

Where T = °Kelvin; R = Reistance; 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



Thermostat
(Normally Closed)
Opens at 90C
Orange (+)
Yellow (-)

HED Power
Black (+)
White (Gnd)

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.

310 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

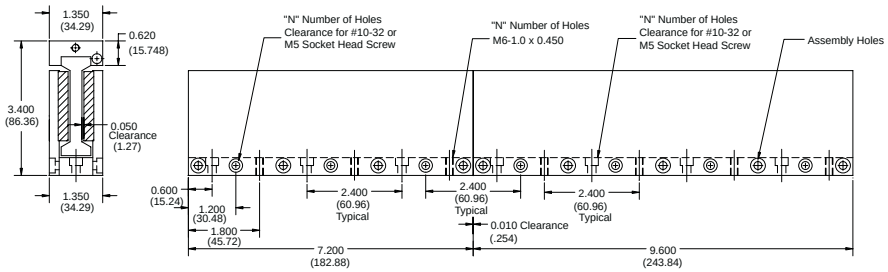
THERMAL

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



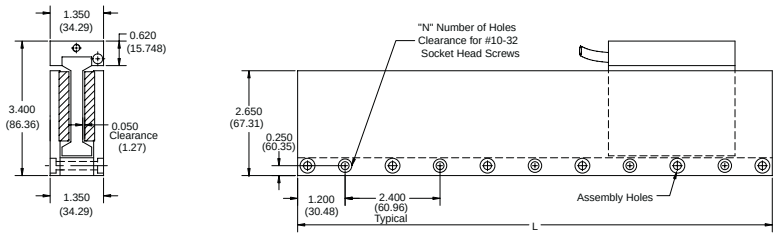
Incremental Length:
2.4in/60.96mm

Minimum Length:
2.4in/60.96mm

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

Weight/Foot:
8.50lbs/ft

MODULAR 310xxM1



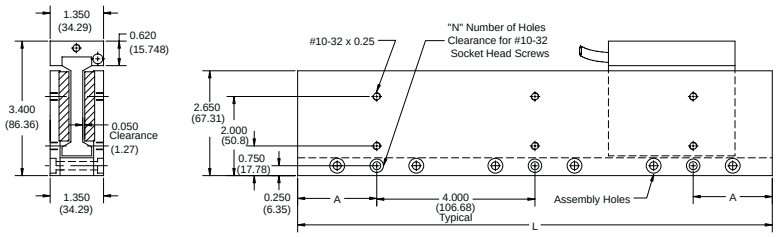
Incremental Length:
2.4in/60.96mm

Minimum Length:
2.4in/60.96mm

Maximum Length:
64.8in/1645.9mm

Weight/Foot:
8.50lbs/ft

SINGLE PIECE 310xxS



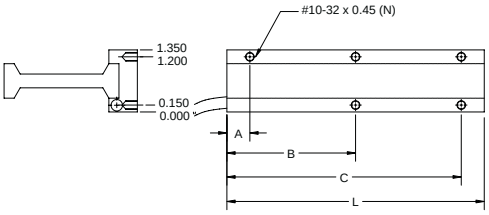
Incremental Length:
1.2in/30.48mm

Minimum Length:
8.4in/213.4mm

Maximum Length:
66in/1676.4mm

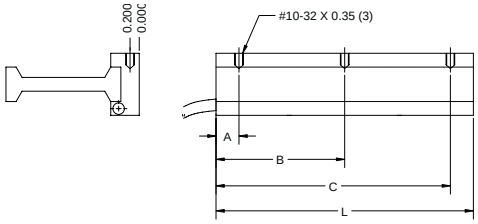
Weight/Foot:
8.50lbs/ft

(A) ENGLISH TOP MOUNTING



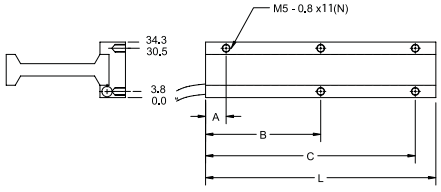
COIL SIZE (inches)	L	N	A	B	C
310-1A	3.20	4	0.50	1.60	2.70
310-2A	5.60	5	0.50	2.80	5.10
310-3A	8.00	5	0.50	4.00	7.50
310-4A	10.40	5	0.50	5.20	9.90
310-5A	12.80	5	0.50	6.40	12.30
310-6A	15.20	5	1.70	7.60	13.50

(B) ENGLISH SIDE MOUNTING



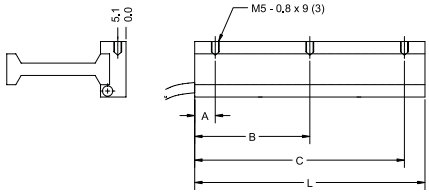
COIL SIZE (inches)	L	N	A	B	C
310-1B	3.20	3	0.50	1.60	2.70
310-2B	5.60	3	0.50	2.80	5.10
310-3B	8.00	3	0.50	4.00	7.50
310-4B	10.40	3	0.50	5.20	9.90
310-5B	12.80	3	0.50	6.40	12.30
310-6B	15.20	3	1.70	7.60	13.50

(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

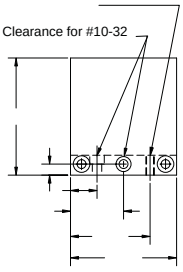
P/N	310xx	S	L (in)	L (mm)	A	A (mm)	N
	31008	S	8.4	205.8	0.20	5.08	3
	31009	S	9.6	235.2	0.80	20.32	3
	31010	S	10.8	264.6	1.40	1.40	3
	31012	S	12.0	294.0	2.00	50.80	3
	31013	S	13.2	323.4	2.60	66.04	3
	31014	S	14.4	352.8	3.20	81.28	3
	31015	S	15.6	382.2	3.80	96.52	3
	31016	S	16.8	411.6	0.40	10.16	5
	31018	S	18.0	441.0	1.00	25.40	5
	31019	S	19.2	470.4	1.60	40.64	5
	31020	S	20.4	499.8	2.20	55.88	5
	31021	S	21.6	529.2	2.80	71.12	5
	31022	S	22.8	558.6	3.40	86.36	5
	31024	S	24.0	588.0	4.00	101.60	5
	31025	S	25.2	617.4	0.60	15.24	7
	31026	S	26.4	646.8	1.20	30.48	7
	31027	S	27.6	676.2	1.80	45.72	7
	31028	S	28.8	705.6	2.40	60.96	7
	31030	S	30.0	735.0	3.00	76.20	7
	31031	S	31.2	764.4	3.60	91.44	7
	31032	S	32.4	793.8	0.20	5.08	9
	31033	S	33.6	823.2	0.80	20.32	9
	31034	S	34.8	852.6	1.40	35.56	9
	31036	S	36.0	882.0	2.00	50.80	9
	31037	S	37.2	911.4	2.60	66.04	9

P/N	310xx	S	L (in)	L (mm)	A	A (mm)	N
	31038	S	38.4	940.8	3.20	81.28	9
	31039	S	39.6	970.2	3.80	96.52	9
	31040	S	40.8	999.6	0.40	10.16	11
	31042	S	42.0	1029.0	1.00	25.40	11
	31043	S	43.2	1058.4	1.60	40.64	11
	31044	S	44.4	1087.8	2.20	55.88	11
	31045	S	45.6	1117.2	2.80	71.12	11
	31046	S	46.8	1146.6	3.40	86.36	11
	31048	S	48.0	1176.0	4.00	101.60	11
	31049	S	49.2	1205.4	0.60	15.24	13
	31050	S	50.4	1234.8	1.20	30.48	13
	31051	S	51.6	1264.2	1.80	45.72	13
	31052	S	52.8	1293.6	2.40	60.96	13
	31054	S	54.0	1323.0	3.00	76.20	13
	31055	S	55.2	1352.4	3.60	91.44	13
	31056	S	56.4	1381.8	0.20	5.08	15
	31057	S	57.6	1411.2	0.80	20.32	15
	31058	S	58.8	1440.6	1.40	35.56	15
	31060	S	60.0	1470.0	2.00	50.80	15
	31061	S	61.2	1499.4	2.60	66.04	15
	31062	S	62.4	1528.8	3.20	81.28	15
	31063	S	63.6	1558.2	3.80	96.52	15
	31064	S	64.8	1587.6	0.40	10.16	17
	31066	S	66.0	1617.0	1.00	25.40	17

310xxM AND 310xxM1 MODULAR

P/N	310xx	M1	L (in)	L (mm)	N
	31002	M/M1	2.4	60.96	1
	31004	M/M1	4.8	121.92	2
	31007	M/M1	7.2	182.88	3
	31009	M/M1	9.6	243.84	4
	31012	M/M1	12.0	304.80	5
	31014	M/M1	14.4	365.76	6
	31016	M/M1	16.8	426.72	7
	31019	M/M1	19.2	487.68	8
	31021	M/M1	21.6	548.64	9
	31024	M/M1	24.0	609.60	10
	31026	M/M1	26.4	670.56	11

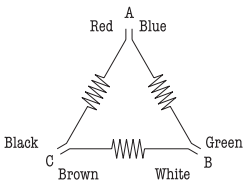
P/N	310xx	M/M1	L (in)	L (mm)	N
	31028	M/M1	28.8	731.52	12
	31031	M/M1	31.2	792.48	13
	31033	M/M1	33.6	853.44	14
	31036	M/M1	36.0	914.40	15
	31038	M/M1	38.1	975.36	16
	31040	M/M1	40.8	1036.32	17
	31043	M/M1	43.2	1097.28	18
	31045	M/M1	45.6	1158.20	19
	31048	M/M1	48.0	1219.20	20
	31050	M/M1	50.4	1280.16	21
	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



P/N 31002 M

WD1

Delta wound with Thermistor
Single Cable: THF08



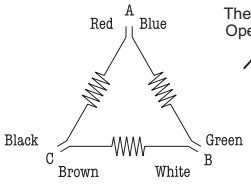
Orange
Thermistor Omega 44004
2.2 kOhms Resistance @ 25°C
Yellow

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

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

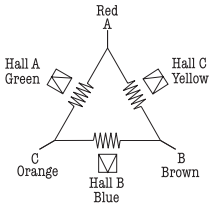
Delta wound with Thermostat
Single Cable: THF08



Thermostat(NC)
Opens at 90°C
Yellow(+)
Orange(-)

WD3

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



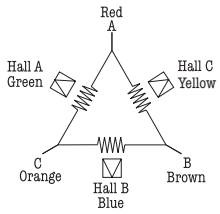
HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

Thermostat(NC)
Opens at 90°C
Grey(+)
Violet(-)

WD4

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



HED Power
Black(+)
White(gnd)
Grey
Thermistor Omega 44004
2.2 kOhms Resistance @ 25°C
Violet

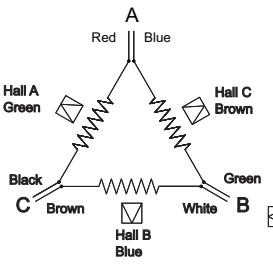
Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

Where T = °Kelvin; R = Reistance; 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



Thermostat
(Normally Closed)
Opens at 90C
Orange (+)
Yellow (-)

HED Power
Black (+)
White (Gnd)

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 100ºC.
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 25ºC. For temperature at 100ºC, multiply resistance by 1.295 (75^{0}C rise * 0.393%/ºC)
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 360º 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.

410 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 pk sine	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 pk sine	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/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
	V/in/s	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

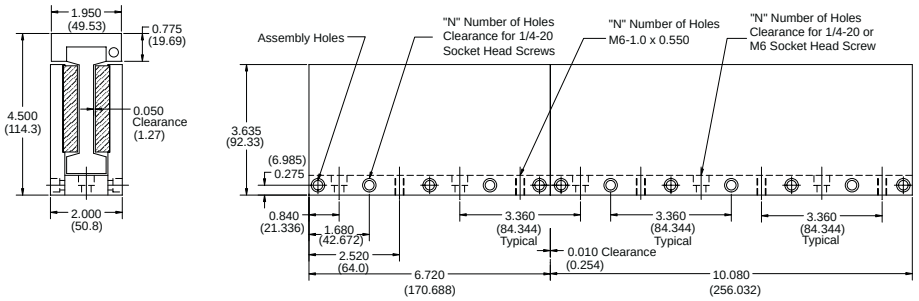
THERMAL

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



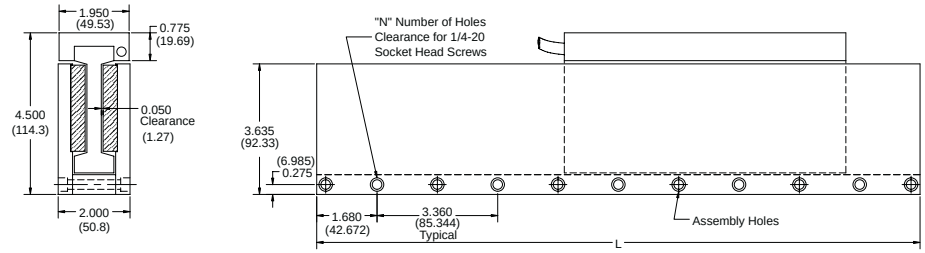
Incremental Length:
3.36in/85.34mm

Minimum Length:
6.72in/170.7mm

Maximum Length:
70.56in/1792.22mm

Weight/Foot:
20.0lbs/ft

MODULAR 410xxM1



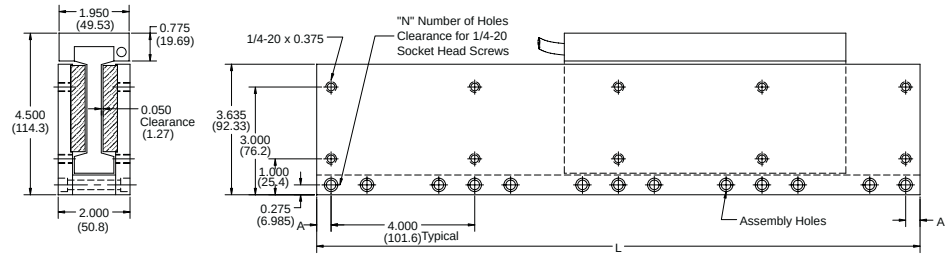
Incremental Length:
3.36in/85.34mm

Minimum Length:
6.72in/170.7mm

Maximum Length:
70.56in/1792.22mm

Weight/Foot:
20.0lbs/ft

SINGLE PIECE 410xxS



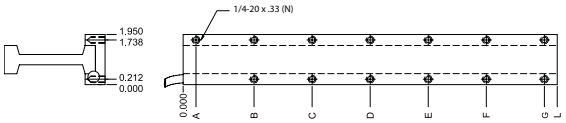
Incremental Length:
1.68in/42.67mm

Minimum Length:
16.80in/426.72mm

Maximum Length:
72.24in/1834.9mm

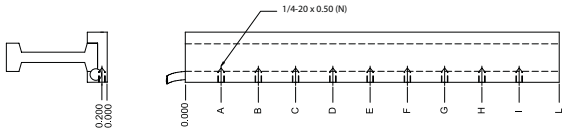
Weight/Foot:
20.0lbs/ft

(A) ENGLISH TOP MOUNTING



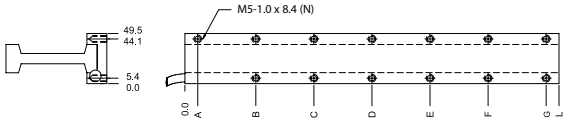
COIL SIZE (in)	L	N	A	B	C	D	E	F	G
410-2A	7.84	5	0.50	3.92	7.34	---	---	---	---
410-3A	11.20	8	0.50	1.60	5.60	9.60	10.70	---	---
410-4A	14.56	9	0.50	3.28	7.28	11.28	14.06	---	---
410-6A	21.28	13	0.50	2.64	6.64	10.64	14.64	18.64	20.78
410-8A	28.00	13	2.00	6.00	10.00	14.00	18.00	22.00	26.00

B) ENGLISH SIDE MOUNTING



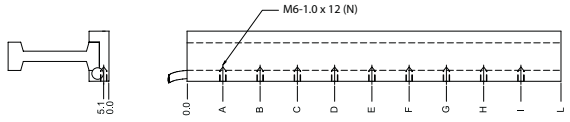
COIL SIZE (in)	L	N	A	B	C	D	E	F	G	H	I
410-2B	7.84	3	2.90	4.90	6.90	---	---	---	---	---	---
410-3B	11.20	3	4.10	7.10	10.10	---	---	---	---	---	---
410-4B	14.56	4	2.78	5.78	8.78	11.78	---	---	---	---	---
410-6B	21.28	6	3.14	6.14	9.14	12.14	15.14	18.14	---	---	---
410-8B	28.00	9	3.50	6.50	9.50	12.50	15.50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

(M) METRIC TOP MOUNTING



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

(N) METRIC SIDE MOUNTING



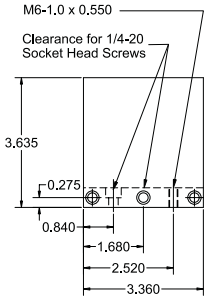
COIL SIZE (mm)	L	N	A	B	C	D	E	F	G	H	I
410-2N	199.1	3	73.7	124.5	175.3	---	---	---	---	---	---
410-3N	284.5	3	104.1	180.3	256.5	---	---	---	---	---	---
410-4N	369.8	4	70.6	146.8	223.0	299.2	---	---	---	---	---
410-6N	540.5	6	79.7	156.0	232.2	308.4	384.6	460.8	---	---	---
410-8N	711.2	9	88.9	165.1	241.3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



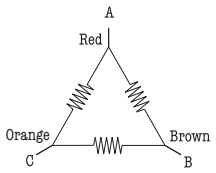
P/N 41003 M

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

WD1

Delta wound with Thermistor
Single Cable: THF05



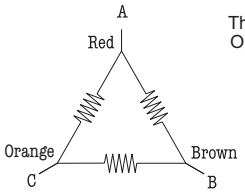
Orange
Thermistor Omega 44004
2.2 kOhms Resistance @ 25°C
Yellow

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

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

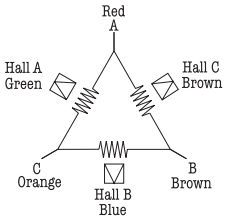
Delta wound with Thermostat
Single Cable: THF05



Thermostat(NC)
Opens at 90°C
Yellow(+)
Orange(-)

WD3

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



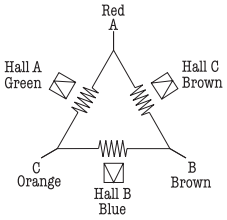
HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

Thermostat(NC)
Opens at 90°C
Grey(+)
Violet(-)

WD4

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



HED Power
Black(+)
White(gnd)

Hall Effect Devices
Symmetrical Response
4.5V to 18 V Operation
Open Collector Output
I_{OUT} Continuous 15 mA

Grey
Thermistor Omega 44004
2.2 kOhms Resistance @ 25°C
Violet

$\frac{1}{T} = A + B(LOG_eR) + C(LOG_eR)^3$

Where T = °Kelvin; R = Reistance; 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

Series
110

Coil size
1 or 2 poles

Mounting
A top, English
B side, English
M top, metric
N side, metric
C custom

Cooling
NC no cooling
AC not available
LC not available

Cable Length
in feet (8 ft. standard)

Winding
S Series
P Parallel
T Triple (not available for 1-pole motor)

Wiring
WD0*, WD1, WD2, WD3, WD4

Magnet Track:

11024M1 - N

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

Magnet coating
N nickel (standard)
B black epoxy

Motor Coil

Order Example:

210 - 2 M - NC - WD2 P - 8

Series
210

Coil size
1, 2, 3 or 4 poles

Mounting
A top, English
B side, English
M top, metric
N side, metric
C custom

Cooling
NC no cooling
AC air cooling
LC liquid cooling

Cable Length
in feet (8 ft. standard)

Winding
S Series
P Parallel
T Triple (not available for 1-pole motor)

Wiring
WD1, WD2,
WD3, WD4, WD7

Magnet Track:

21024M1 - N

210xxM:	21007M, 21009M	7.20”, 9.60” modular sections
21507M:	21507M, 21509M	7.20”, 9.60” modular sections
210xxM1:	21048M1 max	48.00” max single piece, 2.4” incr.
210xxM:	21048M max	48.00” max single piece, 2.4” incr.
215xxM:	21524M max	24.00” max single piece, 2.4” incr.
210xxS:	21048S max	48.00” max single piece, 1.2” incr.

Magnet coating
N nickel (standard)
B black epoxy

How to order - 310

Motor Coil

Order Example:

310 - 2 A - NC - WD2 P - 8

Series
310

Coil size
1, 2, 3, 4, 5, or 6 poles

Mounting
A top, English
B side, English
M top, metric
N side, metric
C custom

Cooling
NC no cooling
AC air cooling
LC liquid cooling

Cable Length
in feet (8 ft. standard)

Winding
S Series
P Parallel
T Triple (not available for 1-pole motor)

Wiring
WD1, WD2,
WD3, WD4, WD7

Magnet Track:

31024M1 - N

310xxM:	31007M, 31009M	7.20”, 9.60” modular sections
31507M:	31507M, 31509M	7.20”, 9.60” modular sections
310xxM1:	31064M1 max	64.8” max single piece, 2.4” incr.
310xxM:	31064M max	64.80” max single piece, 2.4” incr.
315xxM:	31524M max	24.00” max single piece, 2.4” incr.
310xxS:	31066S max	64.8” max single piece, 1.2” incr.

Magnet coating
N nickel (standard)
B black epoxy

Motor Coil

Order Example:

410 - 2 B - NC - WD2 P - 8

Series
410

Coil size
1, 2, 3, 4, 5, or 6 poles

Mounting
A top, English
B side, English
M top, metric
N side, metric
C custom

Cooling
NC no cooling
AC air cooling
LC liquid cooling

Cable Length
in feet (8 ft. standard)

Winding
S Series
P Parallel
T Triple (not available for 1-pole motor)

Wiring
WD1, WD2,
WD3, WD4

Magnet Track:

41024M1 - N

410xxM:	41006M, 41010M	6.72", 10.08" modular sections
410xxM1:	41070M1max	70.56" max single piece, 3.36" incr.
410xxM:	41070M max	70.56" max single piece, 3.36" incr.
410xxS:	41072S max	70.56" max single piece, 1.68"

Magnet coating
N nickel (standard)
B black epoxy

ML50 Specifications

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 pk sine	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 pk sine	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

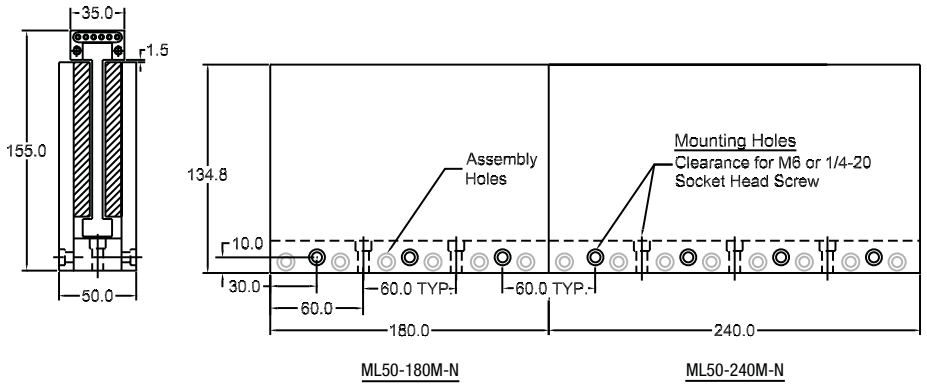
THERMAL

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	mm	120	180	240	360	480	540
(does not include connector module	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



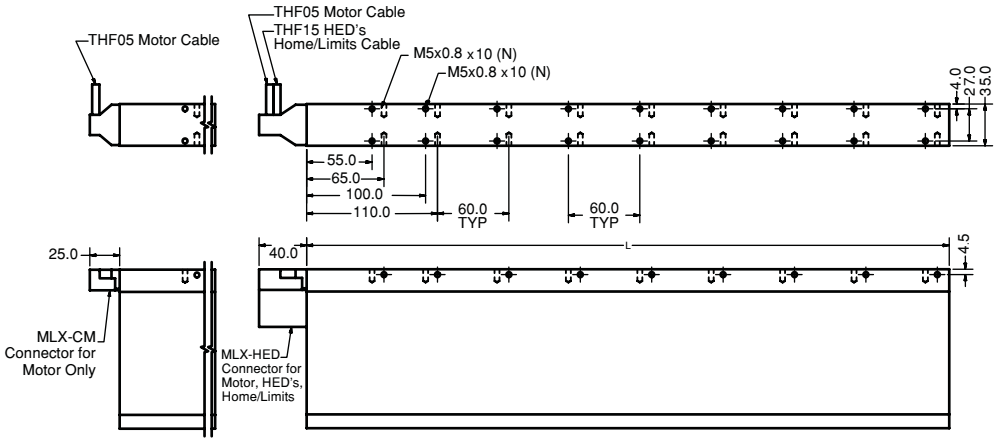
Incremental Length:
60mm

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

1. Peak force and current based on 5% duty cycle and 1 sec 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 1.0A thru one motor lead and 0.5A thru other two leads. Also, BackEMF (V/in/sec) * 7.665 = Force constant (lb/A).
4. Motor resistance measured between any two motor leads with motor connected in WYE winding at 25°C. For temperature at 100^0C, 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 1kHz with the motor in the magnetic field.
7. Electrical Time Constant is time it takes for motor current to reach 63% of it's final value after a step change in voltage.
8. Thermal Time Constant is time it takes for motor temperature to reach 63% of it's 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.

Motor Coil

Order Example:

ML50 - 2 E - NC - M S

Series
ML50

Coil size
2, 3, 4, 6, 8, or 9 poles

Mounting
E Standard
C custom

Winding
S Series
P Parallel
T Triple
D Double parallel

Module ready
Receives connector module

Cooling
NC no cooling
AC not available
LC not available

Magnet Track:

ML50 240M M - N

Series
ML50

Track length
180 - 240 mm

Magnet coating
N nickel (standard)

Magnet coating
M modular
C custom

Magnet Track:

MLX CM R - 1

Series
MLX

device description
CM connector module
HED Hall effects device with limits

Cable length
1 meter (standard)

Module type