

CHAPTER FOUR

4 Hardware Reference

IN THIS CHAPTER

- APEX Drive Specifications
 - Input/Output Pinouts and Circuit Diagrams
 - Motor Specifications, Speed/Torque curves, and Dimensions
-

APEX DRIVE GENERAL SPECIFICATIONS

INPUT POWER – L1/L2/L3

	APEX10	APEX20	APEX40
Voltage Range	85-252VAC (1-phase)	85 – 252VAC (1- or 3-phase)	85 – 252VAC (1- or 3-phase)
Frequency Range	47-66 Hz	47-66 Hz	47-66 Hz
Current (max. continuous)	10A (rms) at 120VAC 1-ph; 10A (rms) at 240VAC 1-ph;	8A (rms) 3-ph	15A (rms) 3-ph
Fuses	No internal fuses. Recommended external fuse: see <i>Chapter 2 Installation.</i>		
Isolation Transformer	Not required	Not required	Not required

Actual input power and current is a function of the motor's operating point (speed and torque) and the duty cycle. The numbers above reflect the servo motor and drive operating at rated speed and rated torque at 100% duty.

INPUT POWER – CONTROL L1/CONTROL L2

	All APEX Drives
Voltage Range	85-252VAC (1-phase)
Frequency Range	47-66 Hz
Current (max. continuous)	1 amp
Power (max. continuous)	0.08 KVA
Fuses	3.0A 250VAC internal fuse. Not user replaceable.
Isolation Transformer	Not required

OUTPUT POWER

		APEX10	APEX20	APEX40
Voltage	(nominal)*	170 or 340VDC	340VDC	340VDC
	(maximum)	420VDC	420VDC	420VDC
Frequency (fundamental)		0 – 400 Hz	0 – 400 Hz	0 – 400 Hz
		15 KHz PWM	8 KHz PWM	8 KHz PWM
Current	continuous	8A sinusoidal	12A sinusoidal	20A sinusoidal
	(per phase)	5.66A rms	8.50A rms	14.14A rms
	peak	16A sinusoidal	24A sinusoidal	40A sinusoidal
	(per phase)	11.31A rms	17.0A rms	28.3A rms
Power (max. continuous)		2.35 KW	3.5 KW	5.9 KW

**Nominal" is with 120VAC or 240VAC input. Output voltage depends on input voltage.
 120VAC input --> 170VDC output
 240VAC input --> 340VDC output

WEIGHT OF DRIVES

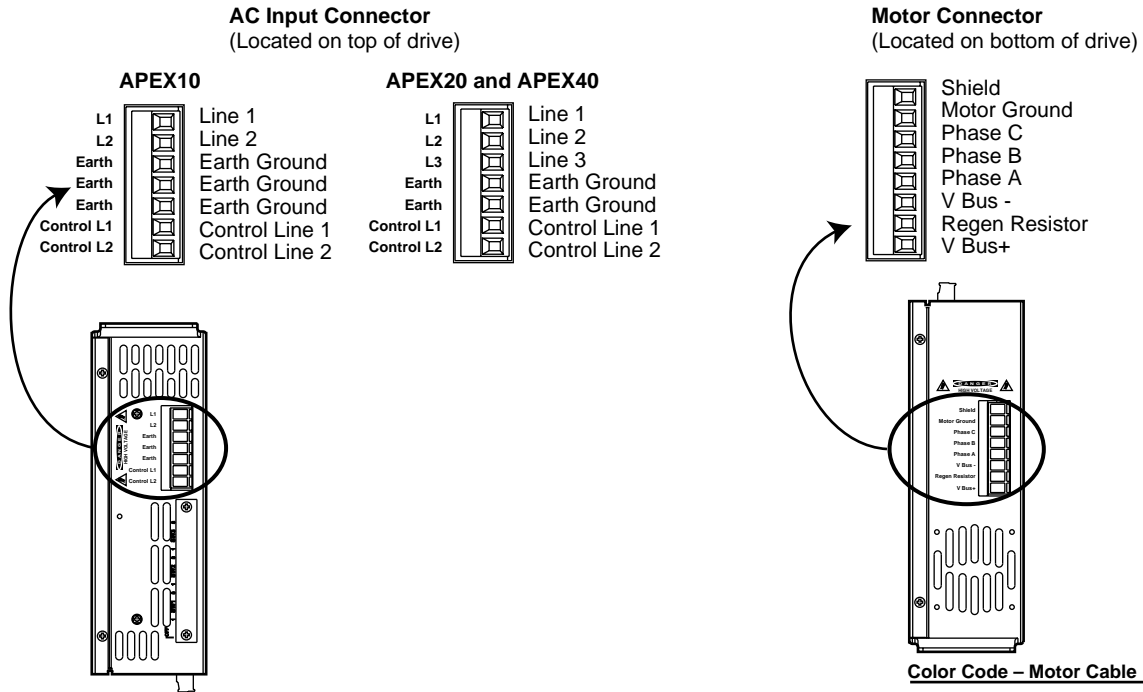
	APEX10	APEX20	APEX40
	9.5 lbs	16.5 lbs	21.5 lbs

I/O PINOUTS & CIRCUIT DRAWINGS

This section is organized by connector. Pin outs and circuit drawings for all APEX Drive input and output connectors are shown in this section.

AC INPUT CONNECTOR AND MOTOR CONNECTOR

For illustration, the APEX10 Drive is shown below. The other APEX Drives are similar.



Mating Connector:
7 pin screw terminal connector
Compumotor P/N 43-013575-01

Color Code – Motor Cable

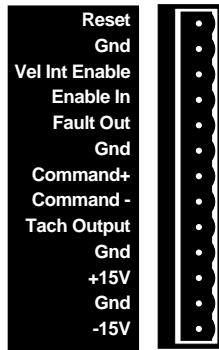
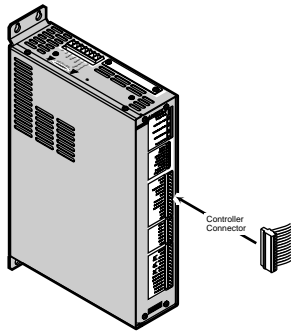
Connector Terminal	SM Cable Wire Color	NeoMetric Cable Wire Color
Phase A	Red/Yellow	Red/Yellow
Phase B	White/Yellow	White/Yellow
Phase C	Black/Yellow	Black/Yellow
Motor Ground	Green/Yellow	Green/Yellow

Mating Connector:
8 pin screw terminal connector
Compumotor P/N 43-014533-01

GROUNDING

Motor Ground and **Shield** (on the motor connector) are connected together internally, and are also connected internally to **Earth** on the AC Input connector, and to the chassis.

CONTROLLER CONNECTOR



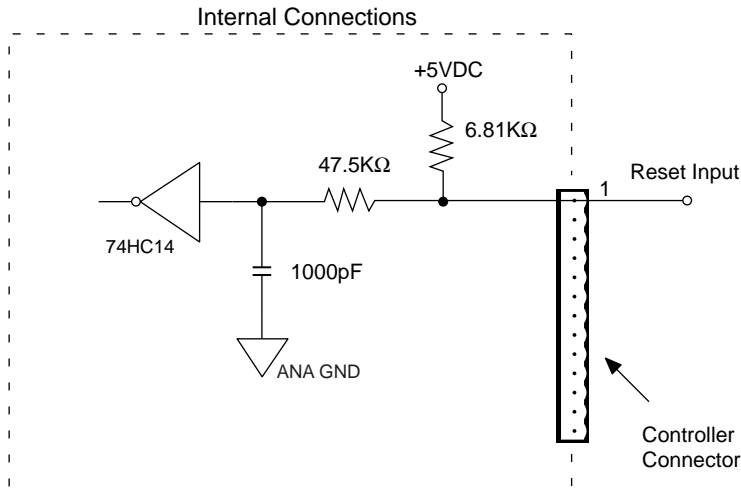
Controller Connector

Pin #:	Function:
1	Reset
2	Ground
3	Velocity Integrator Enable
4	Enable In
5	Fault Output
6	Ground
7	Command+
8	Command—
9	Tachometer Output
10	Ground
11	+15V
12	Ground
13	—15V

Mating Connector:
 13 pin screw terminal connector
 Compumotor P/N 43-013802-01

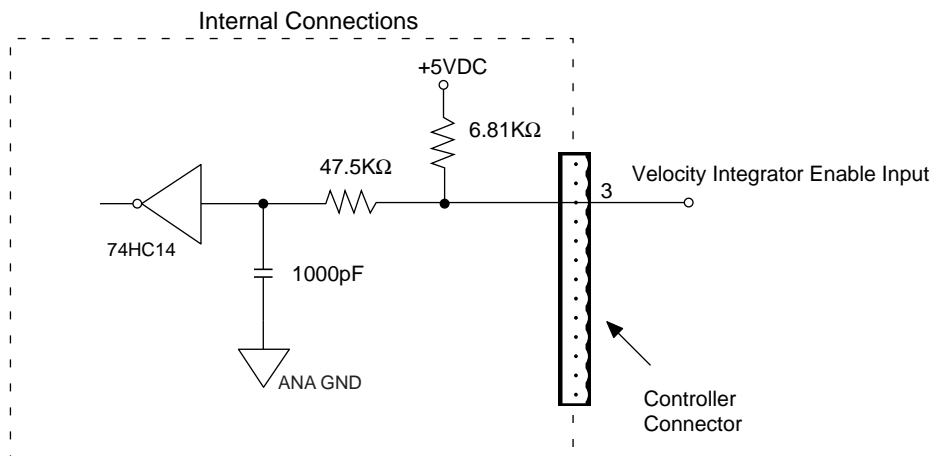
Schematic diagrams of each input and output on the controller connector are shown below.

RESET INPUT



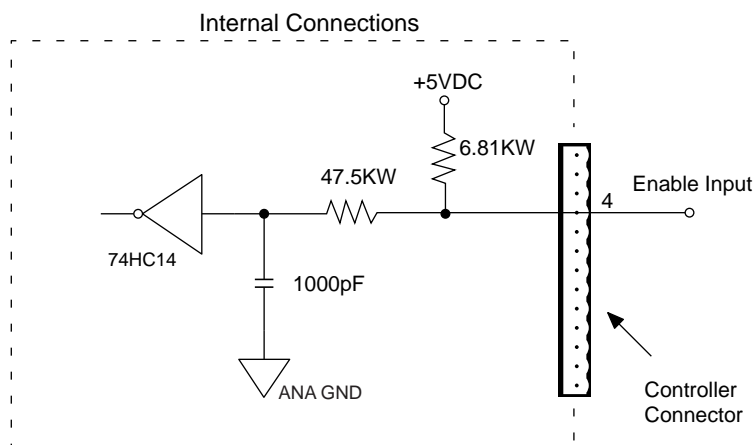
- ❑ **Active Low:** to reset drive, hold reset input at low voltage for at least 20 milliseconds.
- ❑ Voltage Low = 1.0V maximum
- ❑ Voltage High = 3.25V – 5.0V
- ❑ Reset will begin when input reset signal (a low voltage) is released.

VELOCITY INTEGRATOR ENABLE



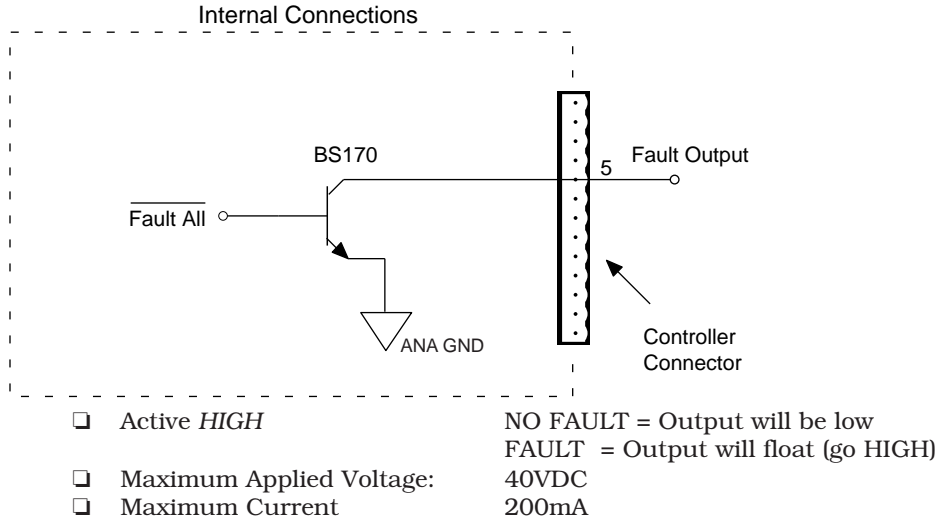
- ❑ *Active Low:* to enable the velocity integrator, hold input at low voltage
- ❑ Voltage Low = 1.0V maximum
- ❑ Voltage High = 3.25V - 5.0V
- ❑ DIP Switch #3, Position 1, must be ON

ENABLE INPUT

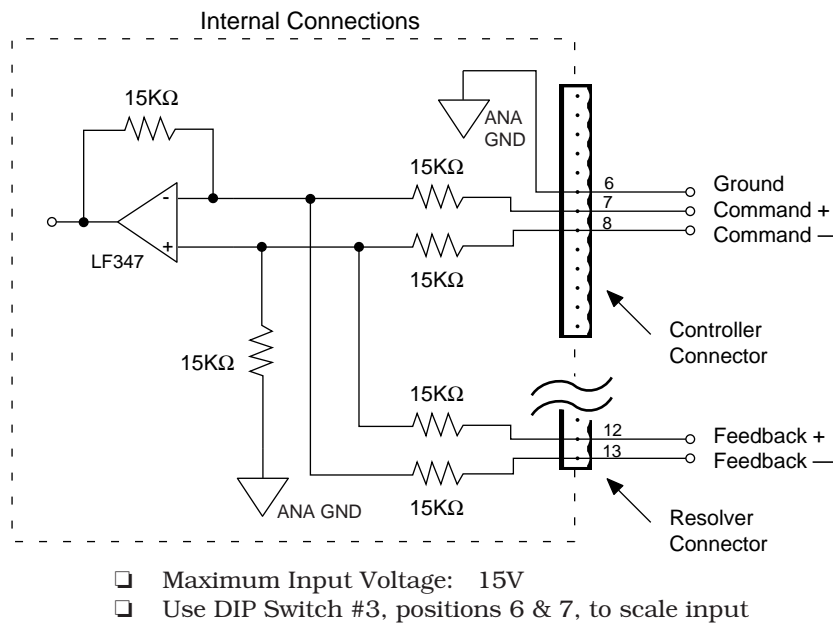


- ❑ *Active Low:* to enable the APEX Drive, hold Enable Input at low voltage
- ❑ Voltage Low = 1.0V maximum
- ❑ Voltage High = 3.25V - 5.0V

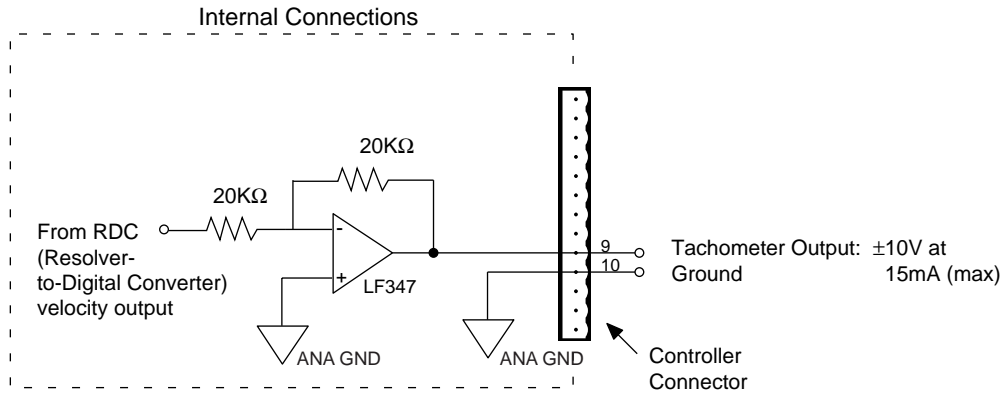
FAULT OUTPUT



COMMAND±

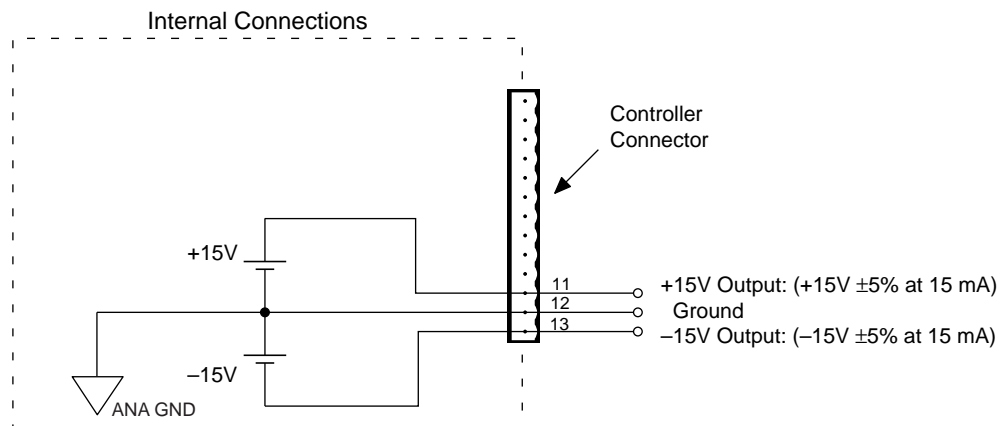


TACHOMETER OUTPUT

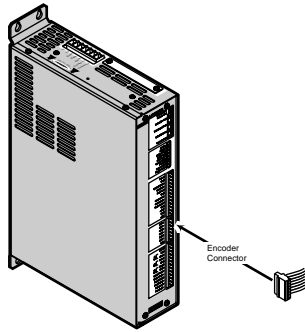


- Use DIP Switch #3, position 5, to scale output:
 - OFF = 1V/1000 rpm for one speed resolvers
 - ON = 1V/1000 rpm for two speed resolvers.

$\pm 15\text{V}$ OUTPUT



ENCODER CONNECTOR



Encoder Output		Hall Effect Input	
Pin #:	Function:	Pin #:	Function:
1	Channel A+	1	No Connect
2	Channel A-	2	No Connect
3	Channel B+	3	Hall +5VDC
4	Channel B-	4	Hall 1
5	Channel Z+	5	Hall 2
6	Channel Z-	6	Hall 3
7	Ground	7	Hall Ground

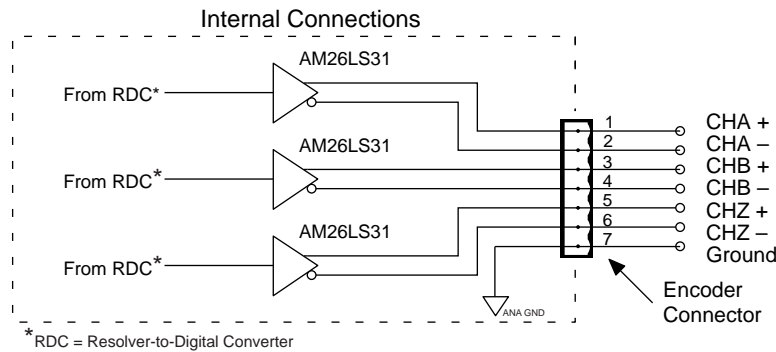
Mating Connector:
 7 pin screw terminal connector
 Compumotor P/N 43-013801-01

The encoder connector is a dual use connector. It can be used for either Encoder Output or for Hall Effect Input. Use DIP Switch #3, position 4, to select the desired function.

- OFF = Encoder Output mode
- ON = Hall Effect Input mode

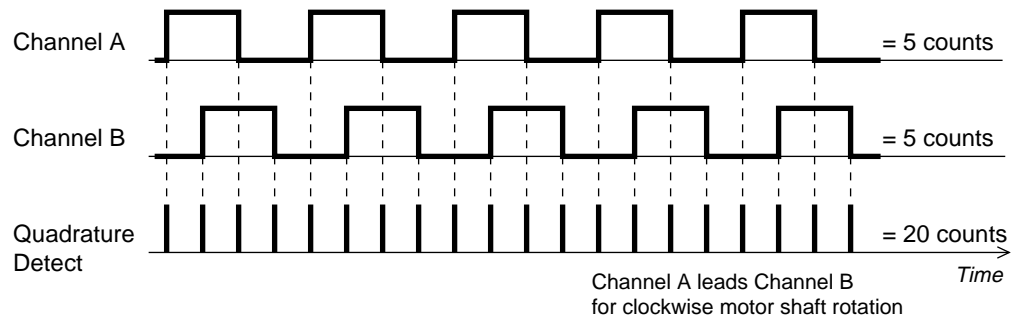
Schematic diagrams of the Encoder Output circuit and of the Hall Effect Input circuit are shown below.

ENCODER – QUADRATURE OUTPUTS



The APEX Drive's encoder outputs are pseudo-quadrature outputs. These quadrature outputs are called *pseudo* because they are derived from resolver information and not from an actual encoder. Resolution is 1024 counts per revolution (pre-quadrature), or 4096 counts per revolution (post-quadrature).

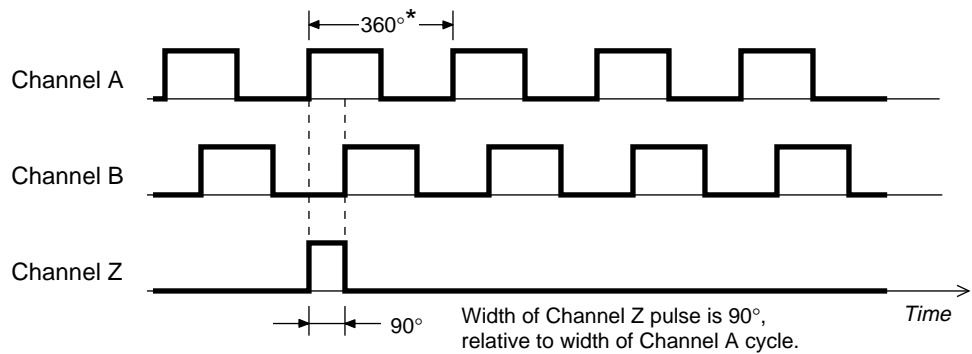
The position of the motor shaft can be determined by counting pulses. The APEX Drive has a *quadrature detect circuit* that enhances resolution. Channels A and B produce two square waves that are 90 electrical degrees apart. When the drive monitors the rising and falling edges of CHA and CHB, each pulse is equivalent to four counts. In this way, the 1024 counts are translated into 4096 counts, as the next figure shows.



The drive determines direction by comparing the phase shift of Channel A relative to Channel B. For example, if Channel A leads channel B, as shown in the previous drawing, the motor shaft is turning in a clockwise direction.

The quadrature outputs are differential (or complementary) outputs. When Channel A+ goes high, Channel A- goes low, and vice versa. Differential outputs increase the system's noise immunity.

The Z Channel, or marker, provides a reference pulse once per revolution. The Z channel outputs (CHZ+, CHZ-) are differential outputs.

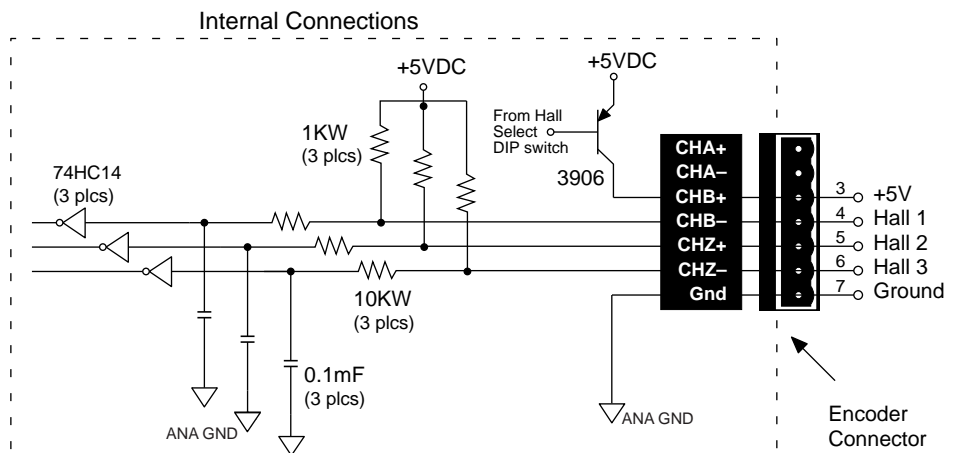


* One electrical revolution. 1024 electrical revolutions = 1 revolution.

The width of the Z channel pulse, relative to the A channel cycle, is 90°.

HALL EFFECT INPUT

When DIP Switch #3, position 4, is in turned ON, the function of the encoder connector changes. The circuit below is connected (instead of the circuit shown on the previous page).



With this circuit active, you can use the connector for Hall effect sensor inputs. The APEX Drive uses the Hall sensor information to determine rotor position, so that it can commutate the motor correctly.

If you use a motor with Hall effect sensors rather than a resolver, connect the Hall cable to the APEX Drive's encoder connector according to the diagram above. Make sure that DIP Switch#3, position#4, is ON *BEFORE* you power up the drive.

Refer to the Resolver Connector section for resolver connections when the APEX drive is in Hall Effect Mode.

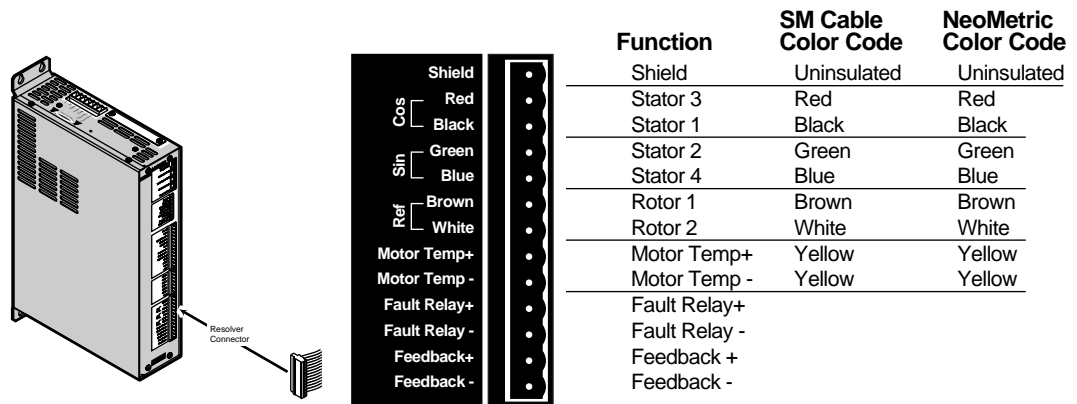
Any encoder connections on the motor will need to be connected to the controller in order to be used.

CAUTION

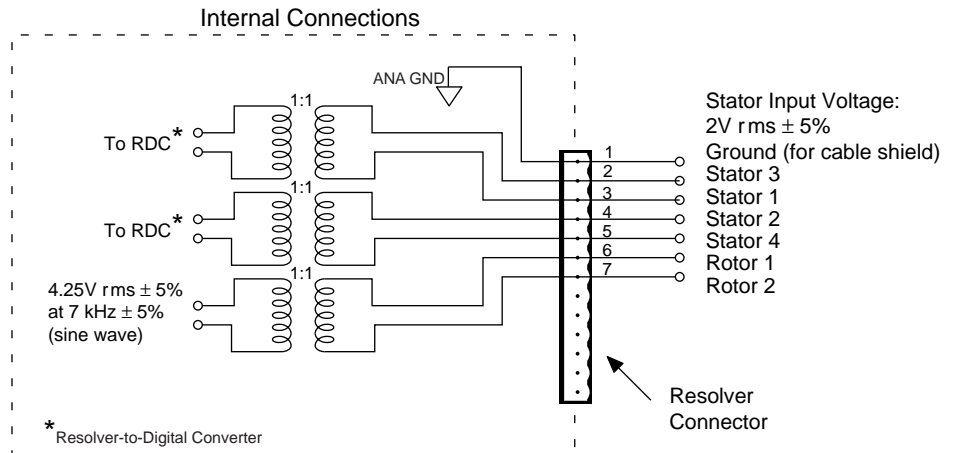
Turn the Hall Select DIP Switch ON before you apply AC power to the APEX Drive. Damage to system components may result from powering up the drive in resolver mode, with Hall effect motors attached.

RESOLVER CONNECTOR

Schematic diagrams of each input and output on the resolver connector are shown below.

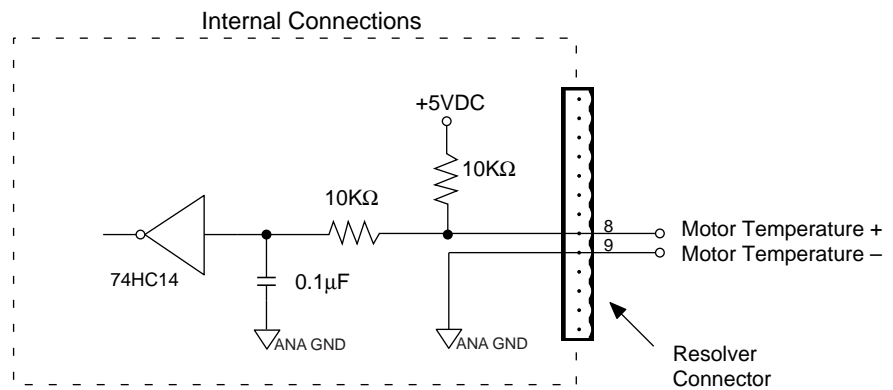


Mating Connector:
13 pin screw terminal connector
Compumotor P/N 43-013802-01



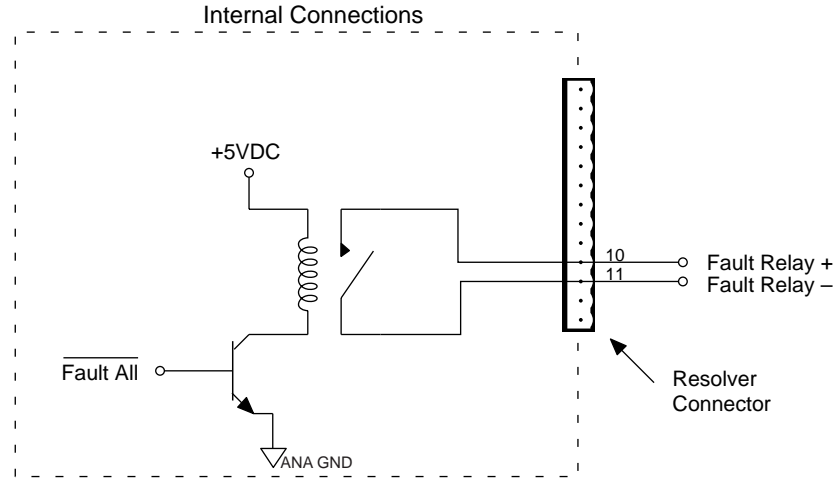
- ❑ DIP Switch #3, position 4, must be OFF so that:
 - Internal microprocessor uses resolver information for commutation
 - Encoder output will be enabled
 - Hall Effect input will be disabled
- ❑ **Shield** (on the resolver connector) is internally connected to all ground terminals (labeled **Gnd**) on the APEX Drive's front panel. These terminals are isolated from **Earth** and **Motor Ground**, and from the chassis.

MOTOR TEMP±



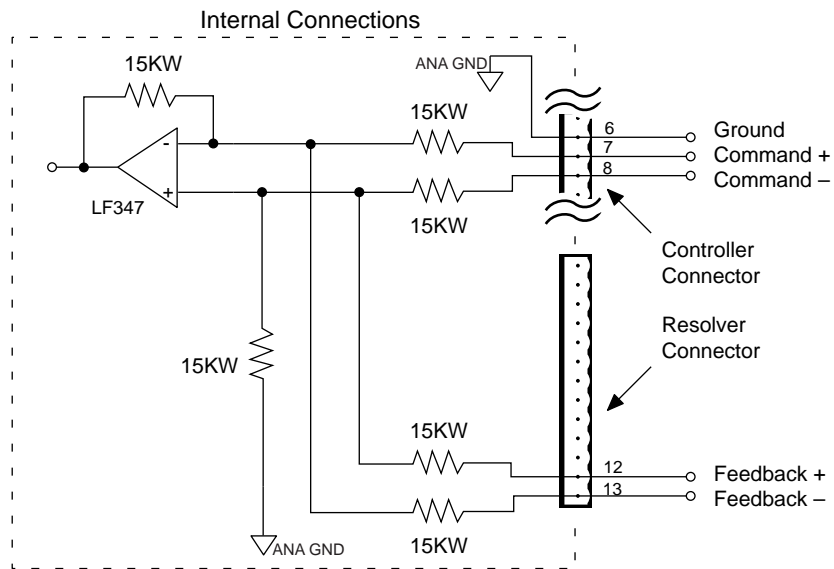
- ❑ Motor's temperature sensor should be *normally closed* (closed at low temperatures; opens at high temperatures.)
- ❑ Short together Motor Temp+ and Motor Temp- if motor does not have a temperature sensor.

FAULT RELAY ±



- ❑ Relay Type: Normally Open
 - Relay will be *OPEN* if drive is disabled, faulted, or power is off
 - Relay will be *CLOSED* when drive is enabled
- ❑ Maximum current rating: 5A at 24VDC, or 5A at 120VAC
- ❑ For more information, see *Motor Braking* in Chapter 3 Special Features

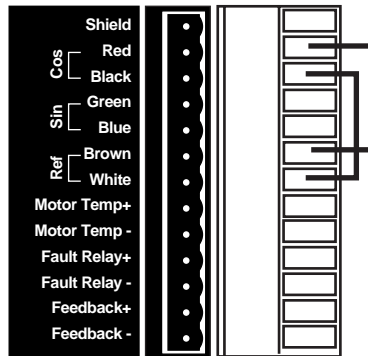
FEEDBACK ±



- ❑ Use for velocity mode operation

RESOLVER CONNECTOR JUMPERS WHEN IN HALL EFFECT MODE

When using the APEX615n in Hall effect mode, Compumotor recommends installing jumper wires on the resolver connector as shown below. Also use the SFB1 command in your start-up program to select an external encoder as your feedback source. Direct questions on this topic to the Compumotor Applications Department at the phone numbers provided on the inside front cover of this document.



Jumpers:
Red to Brown
Black to White

MOTOR SPECIFICATIONS

Speed/torque curves, motor specifications, and dimensions are shown on the following pages.

MOTOR BRAKES

Optional motor brakes are available. They are mounted directly behind the motor and are pre-assembled at the factory. When ordering the brake option, specify the motor type.

Brakes	70mm or 34 frame	92mm
Static rated torque	24 in-lb	72 in-lb
Coil voltage	24 VDC	24 VDC
Coil current	0.8 amps	0.52 amps
Weight	1.0 lbbs	2.51 lbs
Inertia	0.000038 lbs-in-sec ²	0.00015 lb-in-sec ²

MOTOR CABLES

SM and NeoMetric cables are available in 10, 25, and 35 foot lengths; APEX motor cables are available in 25, 50, and 100 foot lengths. You can also order custom cables of any length. Call Compumotor's Customer Service Department (800-722-2282). Cable lengths in excess of 100 feet are not recommended.

MOTOR DATA

The data sheets do not assume operation from an APEX drive. The torque specifications reflect the motor's capabilities. In most cases, the motor windings match the drive's output power with an additional safety margin.

POSITIONAL REPEATABILITY

Repeatability: ± 0.088 degrees, unloaded

POSITIONAL ACCURACY

Resolver Accuracy: ± 10 arc minutes

Resolver-to-Digital Converter Accuracy: ± 10 arc minutes

RESOLUTION

Resolver: 4096 counts/rev

SELECTING DRIVE/MOTOR COMBINATIONS

We recommend selecting motors for use with APEX Drives as follows:

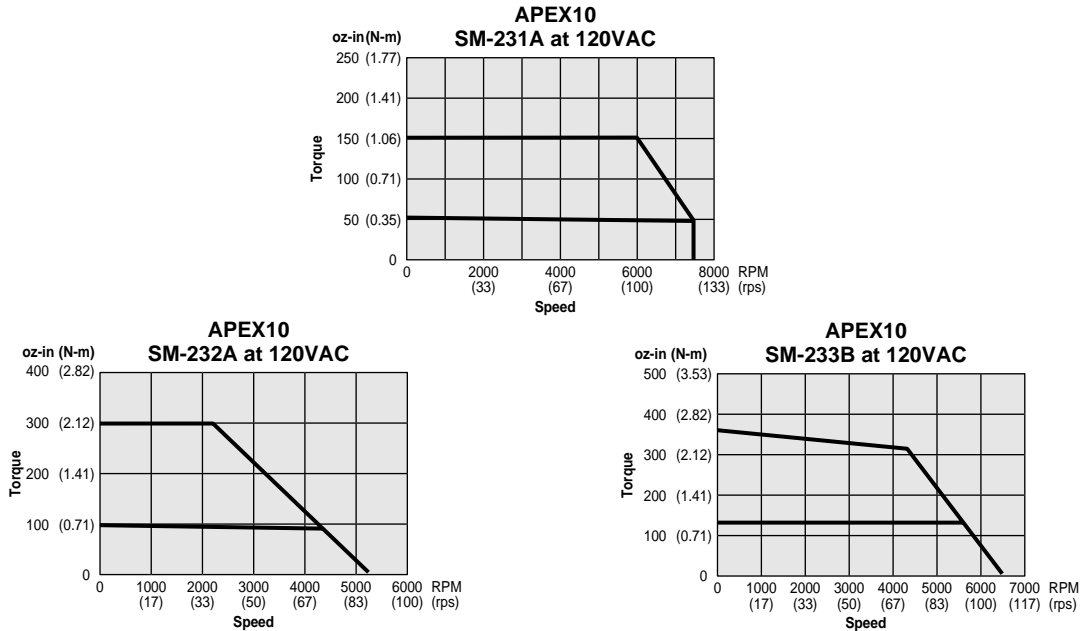
- APEX10 Drive:** SM-231A, SM-232A, SM-233B, N0701F, N0702E, N0703F, N0703G, N0704F, N0704G, N0921F, N0921G, N0922G
- APEX20 Drive:** N0703G, N0704G, N0921G, N0954G, N0922G, N0922J, N0923H
- APEX40 Drive:** APEX620, APEX630, APEX635, APEX640, N0922J, N0923H, N0923K, N0924J, N0924K
- Resolution Resolver:** 4096 counts/REV

SPEED/TORQUE CURVES

Speed/torque curves on these pages represent the available shaft torque at different operating speeds, under the following conditions:

- SM and NeoMetric Motors:**
 25° C (77°F) ambient temperature
 Nominal torque constant K_t
 Motor mounted to heatsink:
 10" x 10" x 0.25" aluminum
 (250 x 250 x 6.3 mm)

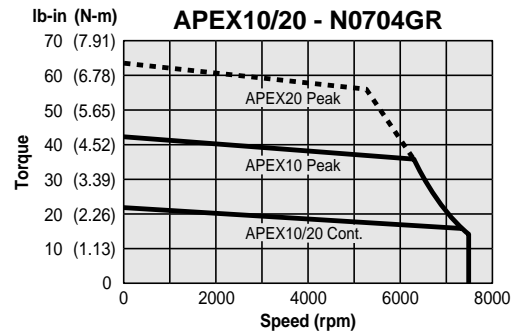
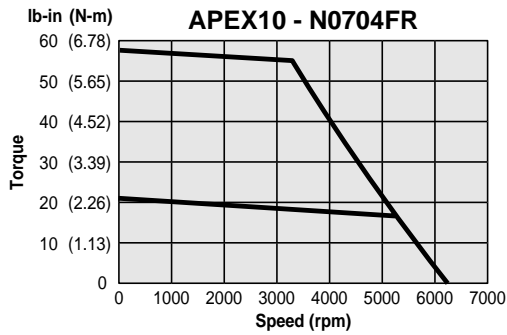
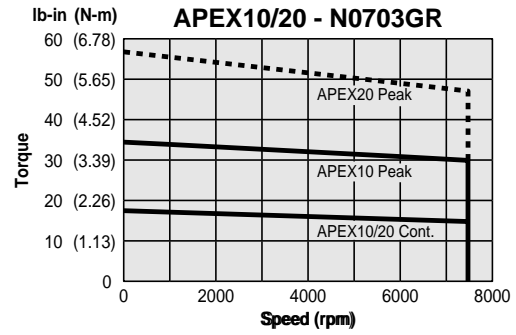
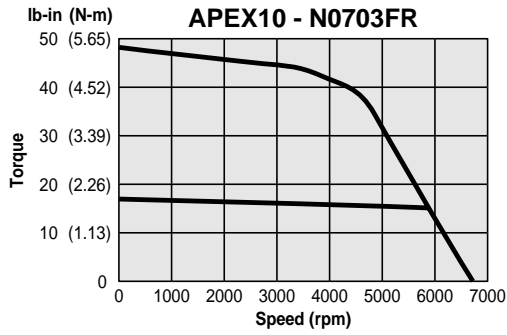
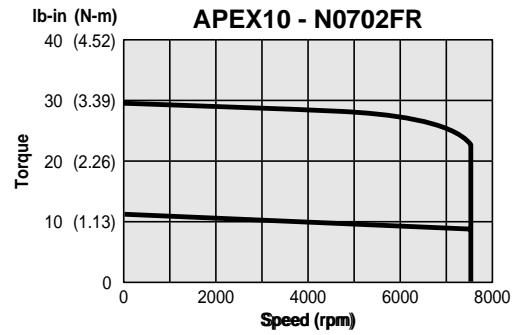
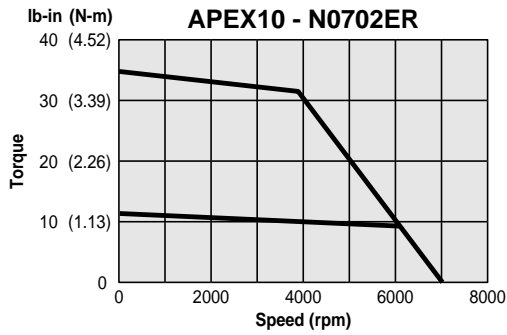
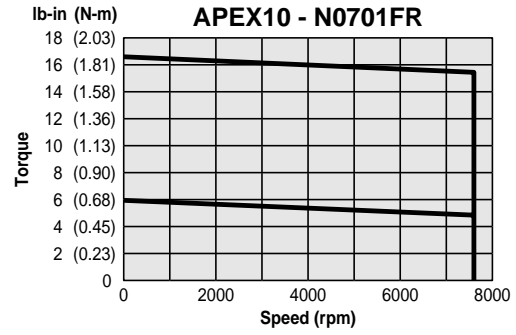
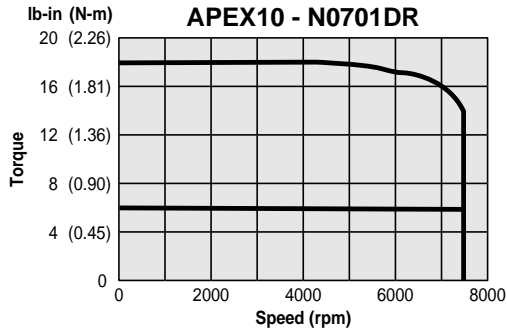
Motor torque may vary $\pm 10\%$ due to motor manufacturing variances.

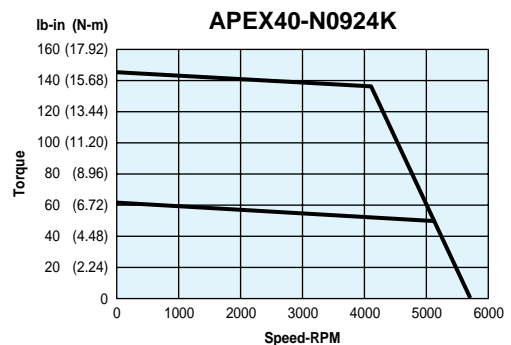
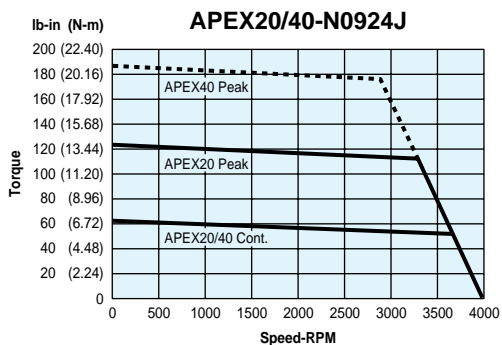
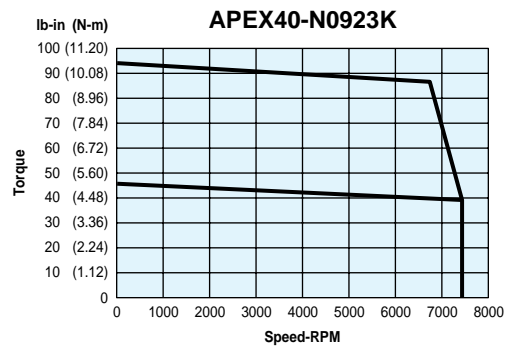
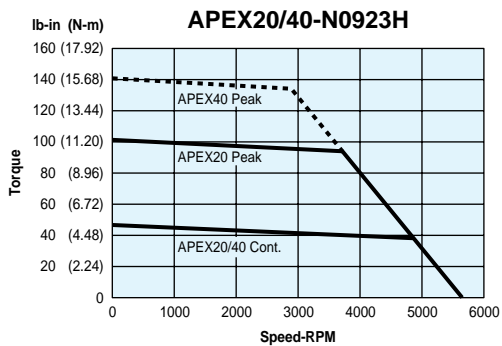
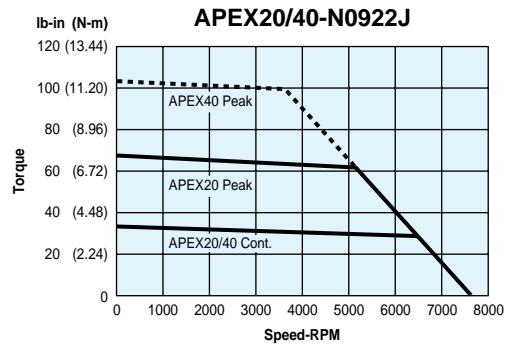
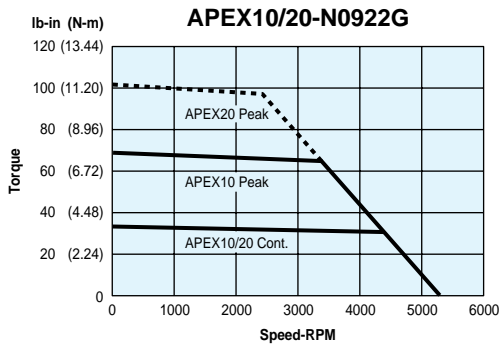
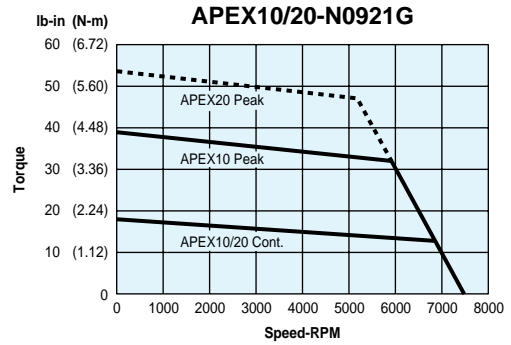
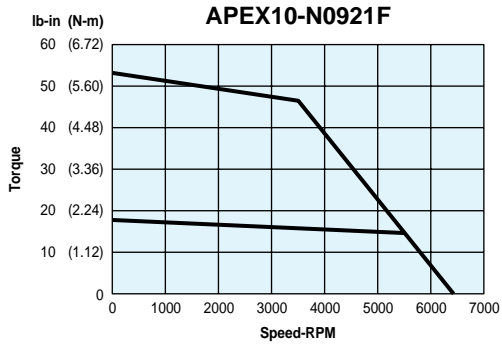


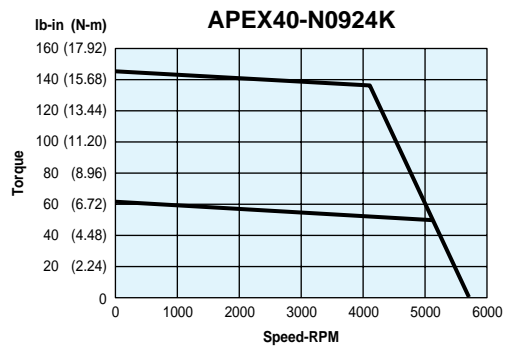
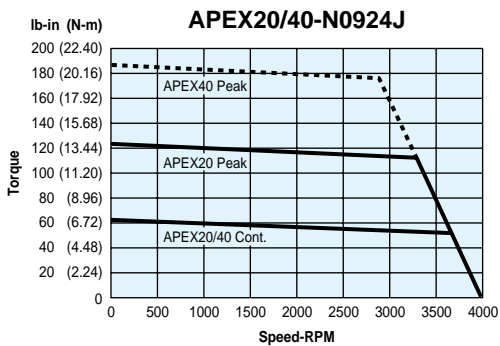
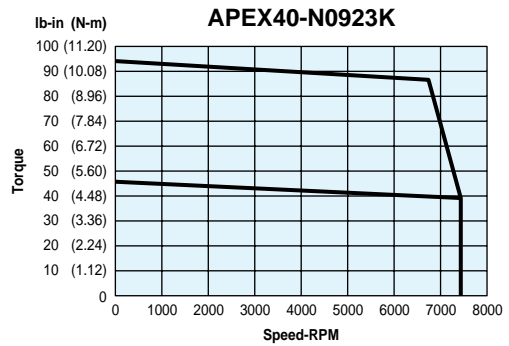
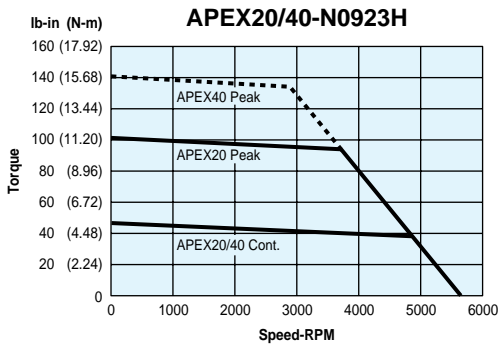
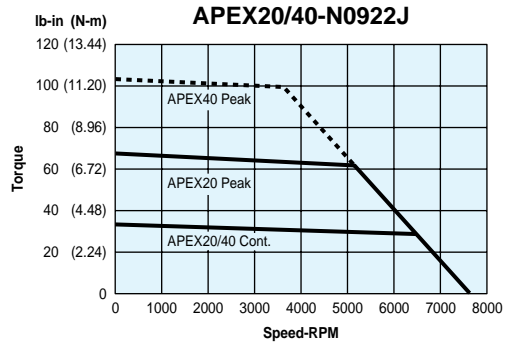
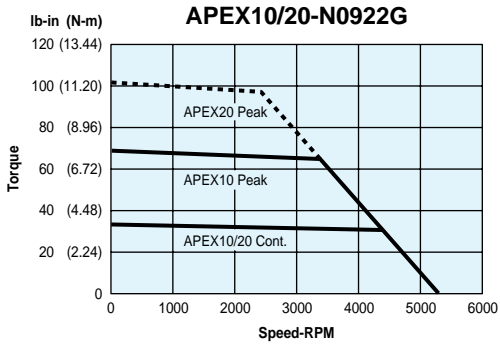
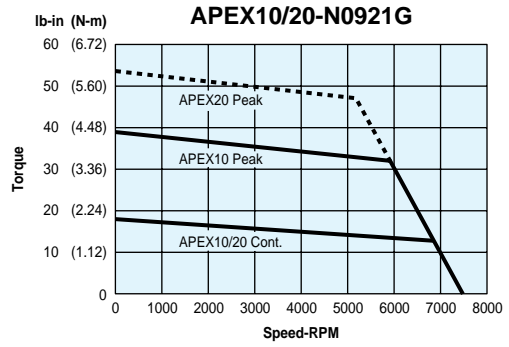
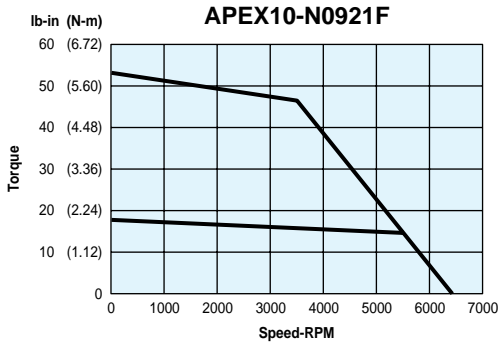
SM Series Motors – Speed Torque Curves

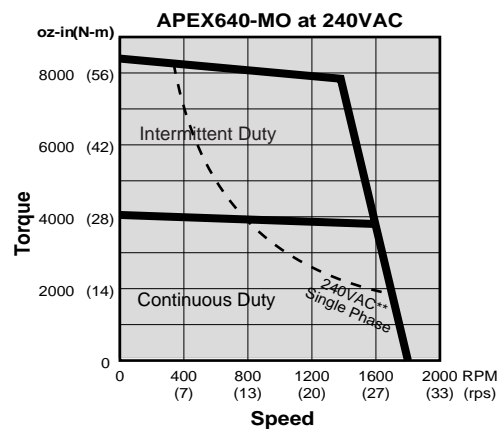
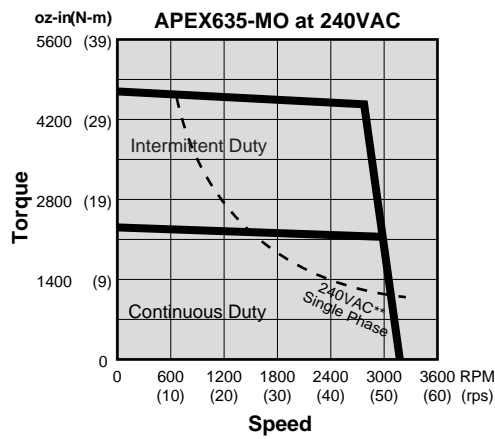
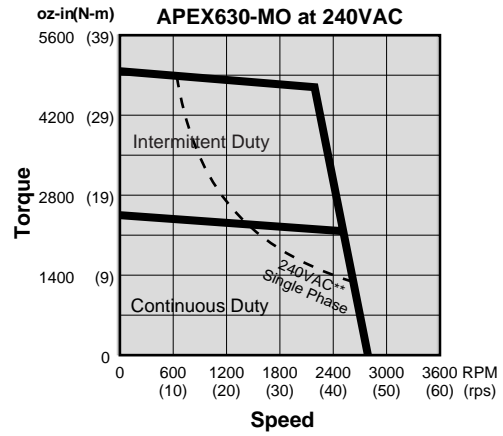
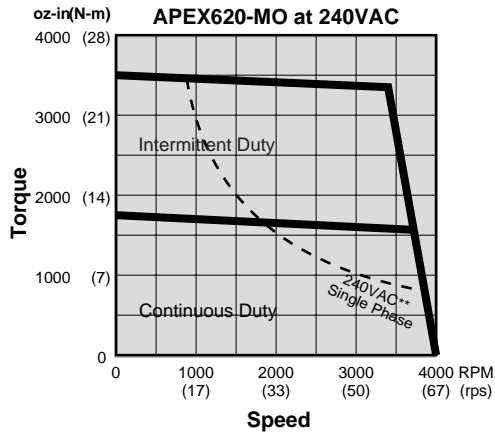
CAUTION

SM Series Servo Motors are optimized for operation with APEX Drives at 120VAC. Do not power the drive with 240VAC if you use an SM Motor.









*240VAC single phase, 8A rms line current
 **240VAC single phase, 20A rms line current

MOTOR SPECIFICATIONS – COMPUMOTOR SM SERIES MOTORS

The specifications table shows motor characteristics. Torque specifications are with rated and peak current for the *motors*. Rated and peak current for the *drive* may be lower — thus, torque may be lower. Consult the specifications table for *motor* capabilities. Consult the speed/torque curves for APEX system capabilities.

Parameter	Symbol	Units	SM231AR	SM232AR	SM233BR
Stall Torque Continuous ¹	T_{CS}	lb-in	3.5	6.7	10.2
		oz. in.	56	107	163
		N-m	0.40	0.76	1.15
Continuous Stall Current ¹	I_{CS}	amperes-rms	2.0	2.0	3.9
Rated Speed	ω_r	rpm	7500	4250	6000
		rps	125	71	100
Peak Torque ¹	T_{pk}	lb-in	17.5	33.4	50.9
		oz. in.	280	535	815
		N-m	1.98	3.78	5.76
Peak Current, rms ¹	I_{pk}	amperes	10	10	19.5
Torque @ Rated Speed ¹	T_C	lb-in	2.8	6.0	9.0
		oz. in.	46	96	145
		N-m	0.32	0.68	1.02
Rated Power-Output Shaft ¹	P_o	watts	250	302	643
		hp	0.34	0.40	0.86
Voltage Constant ^{3,4,6}	K_b	volts/radian/sec	0.161	0.310	0.242
Voltage Constant ^{3,4,6}	K_e	volts/KRPM	16.86	32.45	25.33
Torque Constant ^{3,4,6}	K_t	oz. in./amp rms	27.82	53.54	41.76
		NM/ amp rms	0.20	0.38	0.29
Resistance ^{1,3}	R	ohms	5.22	7.5	2.58
Inductance ⁵	L	millihenries	1.64	2.9	1.06
Thermal Resistance ¹	R_{th}	°C/watt	2.23	1.58	1.26
Motor Constant	K_m	oz. in./√watt	9.57	15.99	21.25
		Nm/√watt	0.07	0.11	0.15
Viscous Damping	B	oz. in./Krpm	.565	.525	.459
		Nm/Krpm	3.86×10^{-3}	3.74×10^{-3}	3.24×10^{-3}
Torque - Static Friction	T_f	oz.in.	1.2	2.0	2.25
		Nm	8.47×10^{-3}	14.10×10^{-3}	15.90×10^{-3}
Thermal Time Constant	τ_{th}	minutes	30	35	40
Electrical Time Constant	τ_e	milliseconds	0.31	0.39	0.41
Mechanical Time Constant	τ_m	milliseconds	13.7	14.5	7.0
Rotor Inertia	J	lb.in.sec ²	0.00048	0.00084	0.00119
		kgm ² *1E-6	54.23	94.91	134.50
Weight	#	pounds	2.6	3.5	4.4
		kg	1.18	1.59	2.00
Winding Class			H	H	H

¹ @25°C ambient with 10 x 10 x 0.25 in. mounting plate, 150°C winding temperature. For 40°C ambient operation, reduce values by 12%.

² RMS current through a single phase of a sinusoidally driven motor

³ ±10% line-to-line

⁴ Peak value

⁵ +/-30% line-to-line, inductance bridge measurement @ 1KHz

⁶ Performance with AC sinusoidal amplifiers can be approximated by review of the amplifiers phase current specification, determining whether ratings are RMS or Peak values. For peak current values, multiply K_t by 0.86. If specified as RMS, multiply K_t by 1.22

All specifications are subject to engineering change

MOTOR SPECIFICATIONS – COMPUMOTOR 70MM (34FRAME) NEOMETRIC SERIES MOTORS

The specifications table shows motor characteristics. Torque specifications are with rated and peak current for the *motors*. Rated and peak current for the *drive* may be lower — thus, torque may be lower. Consult the specifications table for *motor* capabilities. Consult the speed/torque curves for APEX system capabilities.

Parameter	Symbol	Units	N0701DR	N0701FR	N0702ER	N0702FR	N0703FR	N0703GR	N0704FR	N0704GR
Stall Torque Continuous ^{1,2}	T_{CS}	lb-in	6.40	6.40	11.90	11.90	18.00	18.00	22.20	22.20
		N-m	0.72	0.72	1.34	1.34	2.03	2.03	2.50	2.50
Continuous Stall Current ¹	I_{CS}	amperes-rms	2.65	4.14	3.05	4.24	4.17	5.79	4.30	5.96
Rated Speed	ω_r	rpm	7,500	7,500	6,480	7,500	5,800	7,500	4,900	7,000
		rps	125	125	108	125	98	125	82	117
Peak Torque ¹	T_{pk}	lb-in	19.20	19.20	35.60	35.60	54.00	54.00	66.60	66.60
		N-m	2.17	2.17	4.02	4.02	6.10	6.10	7.50	7.50
Peak Current, rms ^{1,6}	I_{pk}	amperes	7.90	12.40	9.10	12.70	12.50	17.40	12.90	17.90
Torque @ Rated Speed ¹	T_C	lb-in	5.80	5.80	9.40	10.40	14.50	15.40	17.50	17.50
		N-m	0.66	0.66	1.06	1.18	1.64	1.74	1.98	1.98
Rated Power-Output Shaft ¹	P_o	watts	510	515	718	919	1,004	1,367	1,014	1,450
Voltage Constant ^{3,4}	K_b	volts/radian/sec	0.221	0.14	0.353	0.253	0.392	0.282	0.468	0.338
Voltage Constant ^{3,4}	K_e	volts/KRPM	23.11	14.67	36.97	26.52	40.99	29.54	49.02	35.36
Torque Constant ^{3,4}	K_t	lb-in/amp rms	2.43	1.55	3.89	2.80	4.32	3.11	5.17	3.73
Resistance ³	R	ohms	5.52	2.27	5.22	2.70	3.36	1.74	3.47	1.80
Inductance ³	L	millihenries	12.98	5.23	15.86	8.16	12.13	6.30	14.50	7.55
Thermal Resistance ¹	R_{th}	°C/watt	1.44	1.44	1.15	1.15	0.96	0.96	0.87	0.87
Motor Constant	K_m	lb-in/√watt	0.83	1.03	1.70	1.70	2.36	2.36	2.77	2.78
Viscous Damping	B	lb-in/Krpm	0.0438	0.0438	0.050	0.050	0.0563	0.0563	0.0625	0.0625
Torque - Static Friction	T_f	oz.in.	1.40	2.10	2.10	2.80	2.80	2.80	3.50	3.50
Thermal Time Constant ⁷	τ_{th}	minutes	45	45	45	45	45	45	45	45
Electrical Time Constant	τ_e	milliseconds	2.35	2.35	3.03	3.03	3.61	3.61	4.19	4.19
Mechanical Time Constant	τ_m	milliseconds	1.60	1.60	0.88	0.88	0.62	0.62	0.56	0.56
Rotor Inertia	J	lb.in.sec ²	0.000128	0.000128	0.000196	0.000196	0.000262	0.000262	0.000329	0.000329
Weight	#	pounds	3.54	3.54	4.53	4.53	6.04	6.04	7.28	7.28
Winding Class			H	H	H	H	H	H	H	H

¹ @25°C ambient with 10 x 10 x 0.25 in. mounting plate, 150°C winding temperature. For 40°C ambient operation, reduce values by 12%

² RMS current through a single phase of a sinusoidally driven motor

³ ±10%, line-to-line, inductance bridge measurement @ 1 kHz

⁴ Peak value

⁵ +/-30% line-to-line, inductance bridge measurement @ 1KHz

⁶ Peak current for 2 seconds maximum with initial winding temperature of 40° C.

⁷ Per NEMA specifications. For I²t considerations, use 10 minutes.

All specifications are subject to engineering change

MOTOR SPECIFICATIONS – COMPUMOTOR 92MM NEOMETRIC SERIES MOTORS

The specifications table shows motor characteristics. Torque specifications are with rated and peak current for the *motors*. Rated and peak current for the *drive* may be lower — thus, torque may be lower. Consult the specifications table for *motor* capabilities. Consult the speed/torque curves for APEX system capabilities.

Parameter	Symbol	Units	N0921F	N0921G	N0922G	N0922J	N0923H	N0923K	N0924J	N0924K
Stall Torque Continuous ^{1,4}	T_{CS}	lb-in	17.7	17.7	34.3	34.3	46.6	46.6	62.5	62.5
		N-m	2.0	2.0	3.88	3.88	5.26	5.26	7.06	7.06
Continuous Stall Current ^{1,2}	I_{CS}	amperes-rms	3.77	5.22	5.6	8.67	7.89	13.85	8.64	12.07
Rated Speed	ω_r	rpm	5,700	7,500	4,375	6,975	4,350	7,500	3,325	4,825
		rps	95	125	72.9	116.2	72.5	125	55.4	80.4
Peak Torque ¹	T_{pk}	lb-in	53	53	103	103	140	140	188	188
		N-m	5.99	5.99	11.6	11.6	15.8	15.8	21.2	21.2
Peak Current, rms ^{1,6}	I_{pk}	amperes	11.3	15.7	16.8	26	23.7	41.6	25.9	36.2
Torque @ Rated Speed ¹	T_C	lb-in	14.0	14.7	27.0	27.0	36.2	36.3	49	47.7
		N-m	1.58	1.66	3.05	3.05	4.09	4.1	5.5	5.39
Rated Power-Output Shaft ¹	P_o	watts	946	1,305	1,397	2,231	1,864	3,222	1,930	2,731
Voltage Constant ^{3,4}	K_b	volts/radian/sec	0.427	0.309	0.556	0.360	0.540	0.305	0.657	0.470
Voltage Constant ^{3,4}	K_e	volts/KRPM	44.66	32.27	58.18	37.69	56.54	31.96	68.83	49.17
Torque Constant ^{3,4}	K_t	lb-in/amp rms	4.71	3.41	6.13	3.97	5.96	3.37	7.25	5.18
Resistance ³	R	ohms	3.72	1.94	2.32	0.96	1.28	0.42	1.22	0.62
Inductance ³	L	millihenries	17.11	8.99	14.72	6.18	14.95	4.78	20.60	10.51
Thermal Resistance ¹	R_{th}	°C/watt	1.06	1.06	0.77	0.77	0.70	0.70	0.62	0.62
Motor Constant	K_m	lb-in/ \sqrt{watt}	1.96	2.45	4.03	4.04	5.26	5.22	6.58	6.57
Viscous Damping	B	lb-in/Krpm	0.075	0.075	0.087	0.087	0.100	0.100	0.1125	0.1125
Torque - Static Friction	T_f	oz.in.	4	4	6	6	8	8	10	10
Thermal Time Constant ⁷	τ_{th}	minutes	60	60	60	60	60	60	60	60
Electrical Time Constant	τ_e	milliseconds	4.6	4.6	6.4	6.4	11.5	11.5	16.9	16.9
Mechanical Time Constant	τ_m	milliseconds	1.13	1.13	0.64	0.64	0.5	0.5	0.41	0.41
Rotor Inertia	J	lb.in.sec ²	0.000532	0.000532	0.000792	0.000792	0.00106	0.00106	0.00132	0.00132
Weight	#	pounds	8.1	8.1	11.7	11.7	15.1	15.1	18.0	18.0
Winding Class			H	H	H	H	H	H	H	H

¹ @25°C ambient with 10 x 10 x 0.25 in. mounting plate, 150°C winding temperature.

² RMS current through a single phase of a sinusoidally driven motor

³ ±10% line-to-line

⁴ Peak value

⁵ +/-30% line-to-line, inductance bridge measurement @ 1KHz

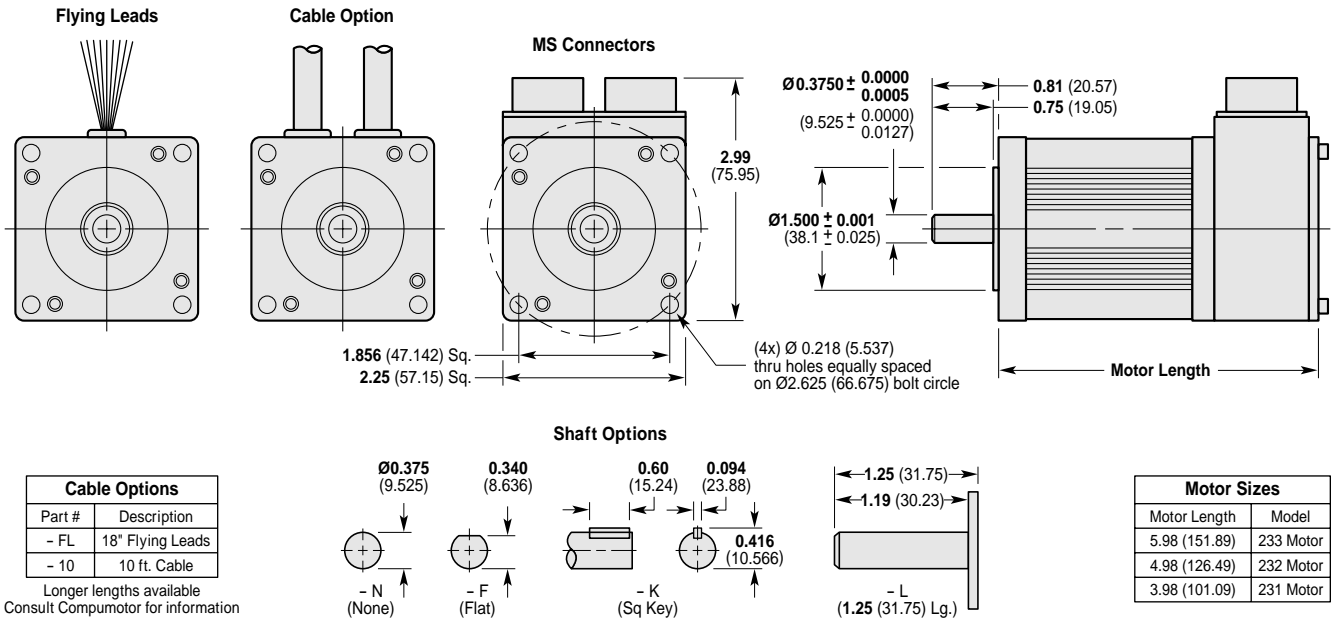
⁶ Peak current for 2 seconds maximum with initial winding temperature of 40° C.

All specifications are subject to engineering change

SM AND NEOMETRIC MOTOR RESOLVER SPECIFICATIONS

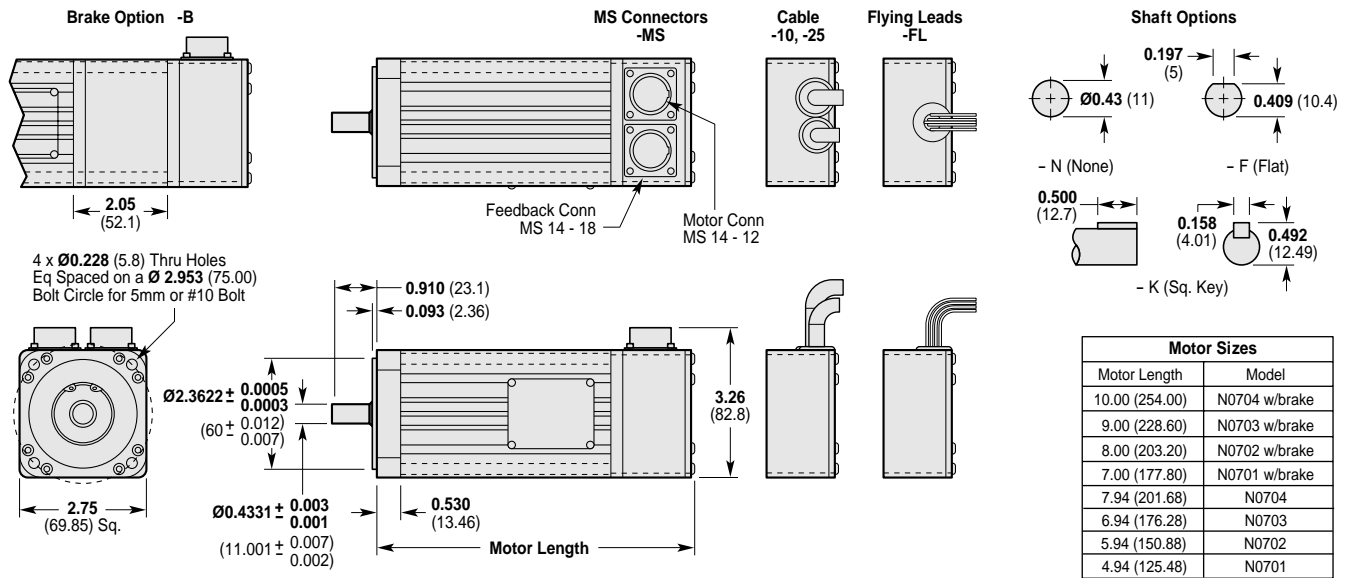
Parameter	Value
Input voltage @ 7000 Hz	4.25 volts
Input current, max.	55 ma
Input power, nominal	0.12 watts
Impedance ZSO (@90°)	58+j145 ohms
Impedance ZRO	53 +j72 ohms
Impedance ZRS	42 +j55 ohms
Transformation ratio	0.470 ±5%
Output voltage	2.0 ±5% volts
D.C. rotor resistance	23 ±10% ohms
D.C. stator resistance	19 ±10% ohms
Sensitivity	35mV/Degree
Max. Error from EZ	±10 minutes
Phase shift, open circuit	5° leading ±3"
Null voltage (total)	20 mV rms
Impedance ZSS	50 +j128 ohms
Inertia	included in motor specification

DIMENSIONS — SM231, SM232, SM233



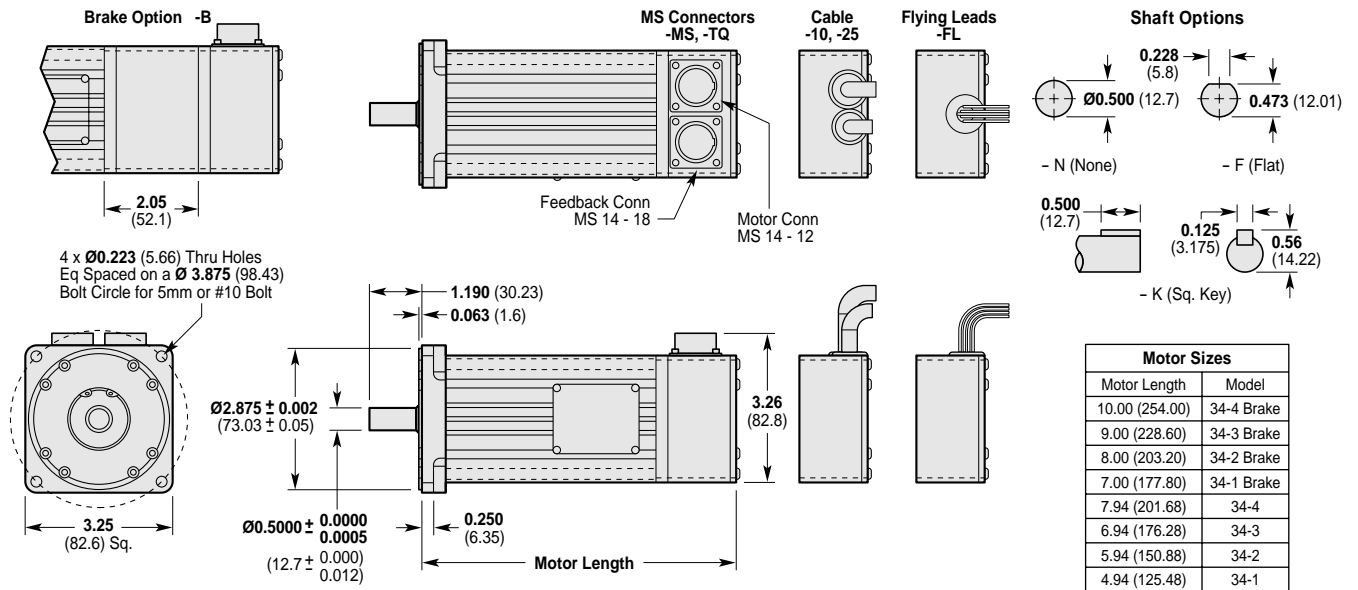
SM231, SM232 & SM233 Motor Dimensions

DIMENSIONS — NEOMETRIC 70MM



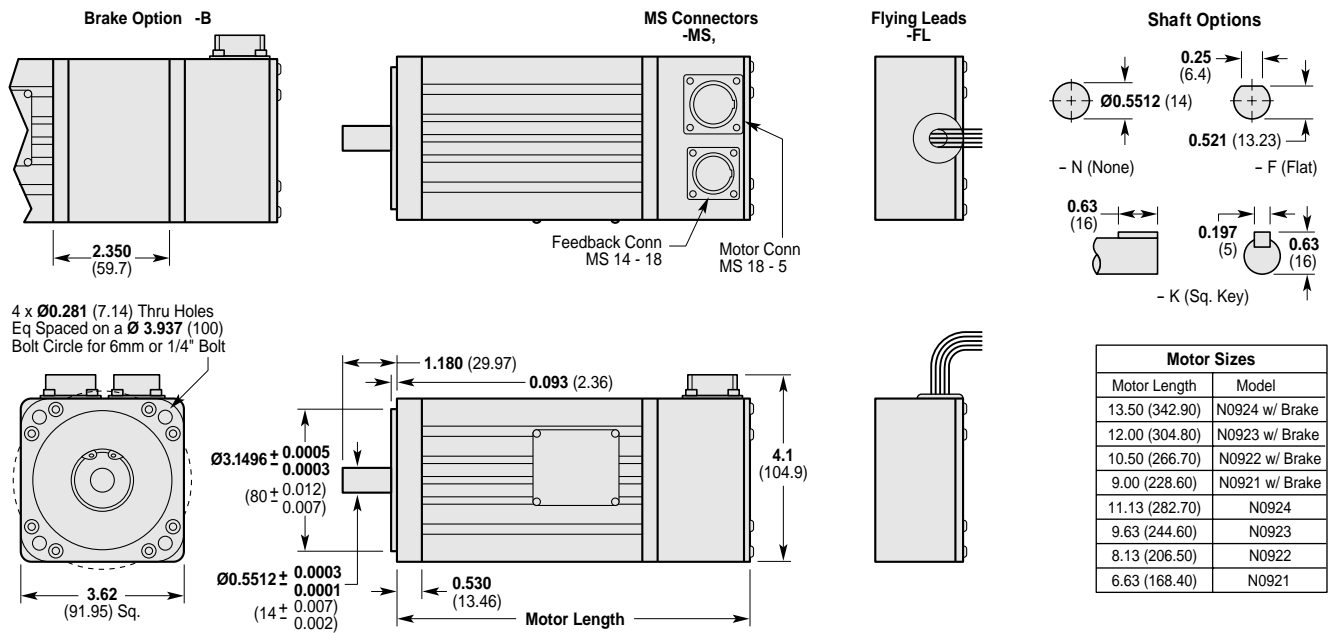
NeoMetric 70mm Motor Dimensions

DIMENSIONS — NEOMETRIC 34



NeoMetric 34 Motor Dimensions

DIMENSIONS — NEOMETRIC 92MM



NeoMetric 92mm Motor Dimensions