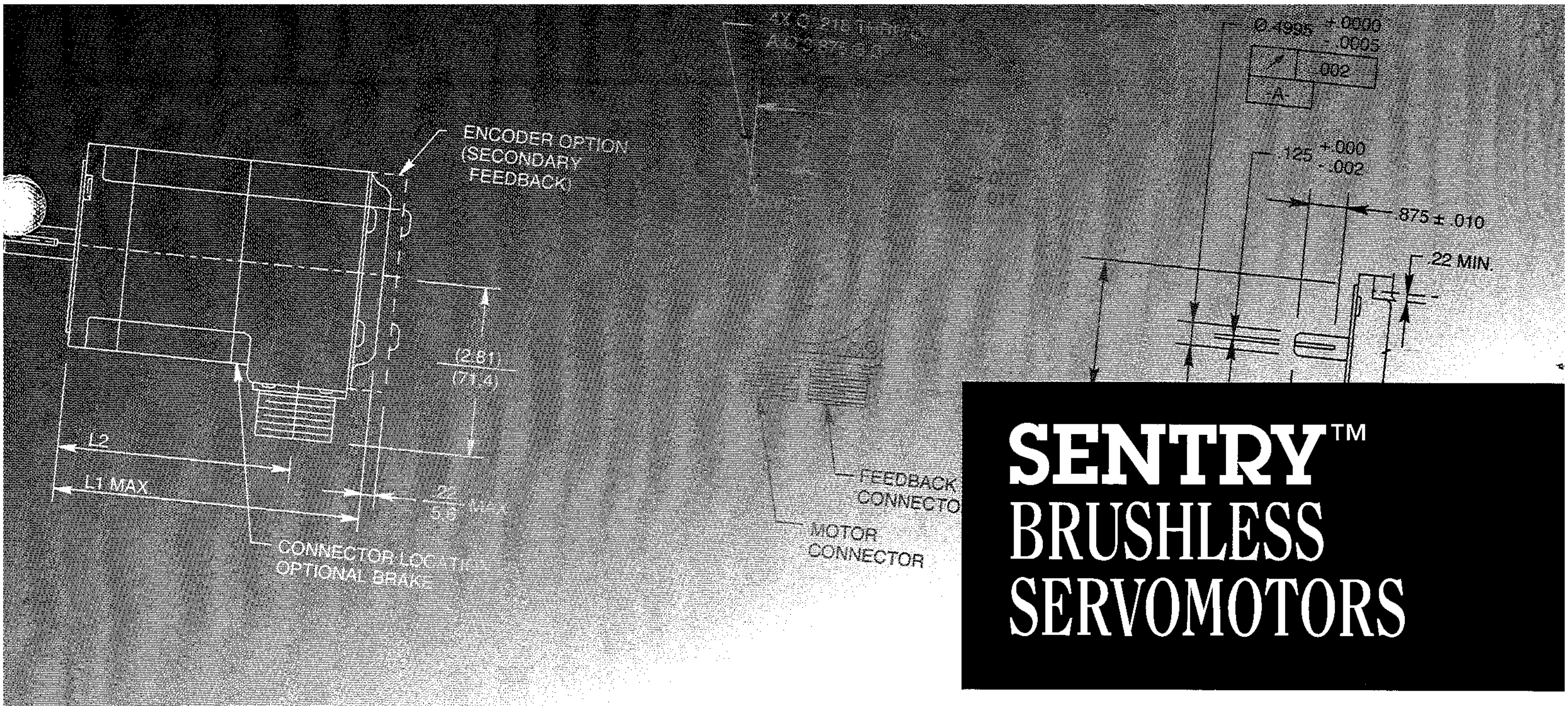
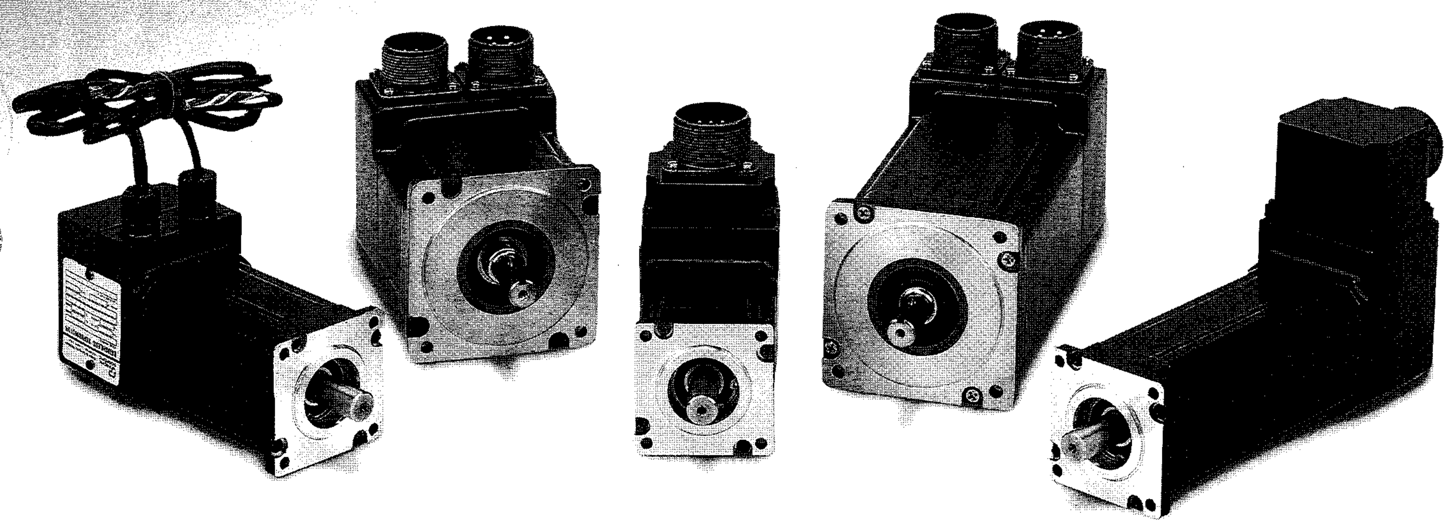


SENTRY™ BRUSHLESS SERVOMOTORS

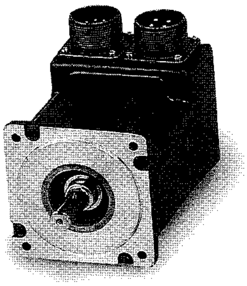
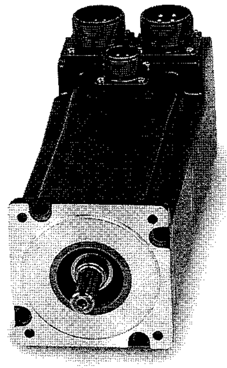
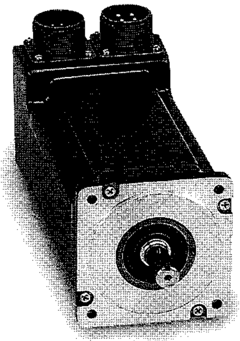
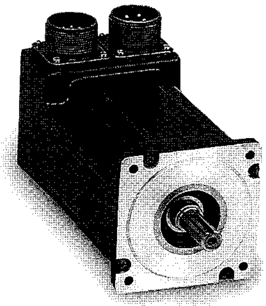


- NEMA 23 & 34 frame sizes... metric mounting also available
- Highest torque per frame size in the industry
- Medium motor inertia for improved load inertia matching

PACIFIC SCIENTIFIC
AUTOMATION TECHNOLOGY GROUP

MOTOR PRODUCTS DIVISION
February, 1997
ISO 9001

SENTRY™ BRUSHLESS SERVOMOTORS

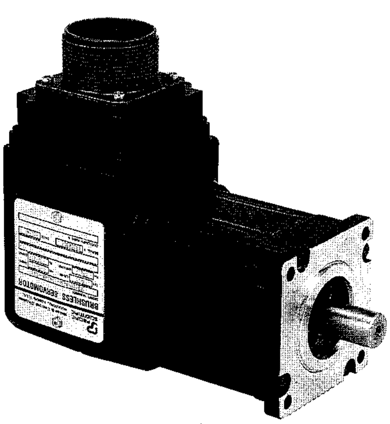
Broad Section

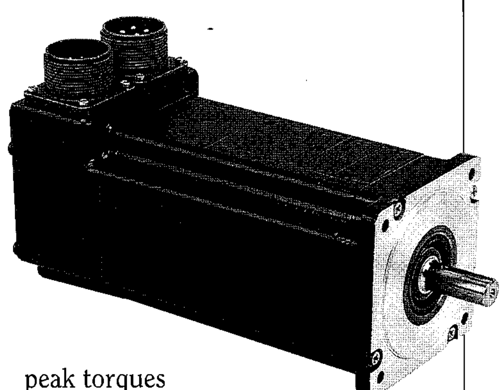
The new **SENTRY** Series NEMA 23 and 34 frame brushless servomotors extend Pacific Scientifics' offering of high performance, reliable brushless servomotors. **SENTRY** complements the existing **REGAL™** series of low inertia products by adding a new medium inertia, high performance family.

High Performance

Designed for demanding torque, velocity and/or positioning applications, the unique **SENTRY** features the industry's highest torque per frame size plus medium rotor inertia for improved load matching.

High torque per frame size provides important application advantages. The **SENTRY** Series provides continuous stall torques up to 13.8 lb-in. (1.56 Nm) for the NEMA 23 frame and 45 lb-in. (5.2 Nm) for the NEMA 34 frame. The NEMA 23 frame provides

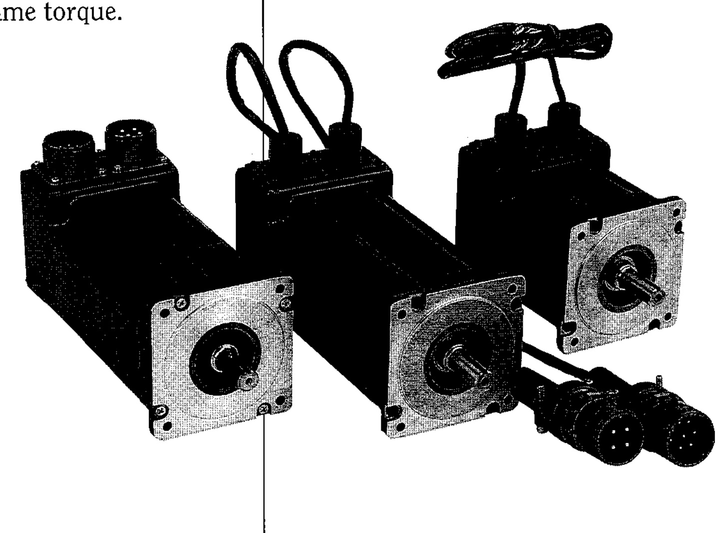




peak torques to 41.5 lb-in. (4.70 Nm) and 131 lb-in. (15.6 Nm) in the NEMA 34 frame. **SENTRY**'s increased torque enhances system performance without increasing the motor frame size and the size of the machine or equipment. A compact motor like **SENTRY** can possibly reduce the size of the machine while providing the same torque.

Load Matching

Medium rotor inertia also provides application advantages. Most closed loop brushless servomotor applications require closely matched load to motor inertias to achieve compliant system stability and the desired system response (bandwidth). Whether coupled directly to the load or through gearing, these considerations are key to the desired result. The **SENTRY** Series medium inertia design permits a closer load inertia match in a broad range of applications. In some applications, **SENTRY** can eliminate the need for gear reduction. Gear reducers are sometimes used to achieve better load matching, but can increase system cost, take up additional space and reduce system reliability.



HIGHEST TORQUE PER FRAME SIZE IN THE INDUSTRY–SENTRY™

FEATURES	BENEFITS
Highest torque per frame size in the industry	Maximum performance in small envelope. Reduce space required for motor or get more torque in same space
Medium rotor inertia for improved load matching	Obtain not only an optimized system response (time), but a stable system response...eliminates gearing sometimes used to achieve better load matching
Standard NEMA and Metric mounting, UL and European Compliance rating	Satisfy broad end use requirements
Peak torque rated at three times continuous current plus good torque linearity beyond continuous ratings	Move loads fast–operate above peak ratings in intermittent duty applications to move loads even faster
Choice of Hall sensor, resolver or encoder feedback	To meet broad drive and system requirements
Compatible with 6-step or sine drives–can furnish special windings for specific drive parameters and torque/speed requirements	Versatile
600 V UL winding insulation system	Maintain motor integrity at higher bus voltages
NEMA 23 & 34 frame sizes- 4.3 to 45 lb-in. continuous stall torque	Addresses wide range of torque requirements
Rugged "housingless" square frame	Efficient use of volume for optimal magnetic circuit
Sealed per IP65 and NEMA specifications	For washdown requirements
Brake option	Improved machine safety
Two year warranty	Quality and reliability
Anti-cog magnet design	Smooth low speed performance
Long life bearing system	Longer motor life for reduced machine downtime
Over temperature thermistor (PTC)	Protection against motor damage

INDEX

How to use this selection guide

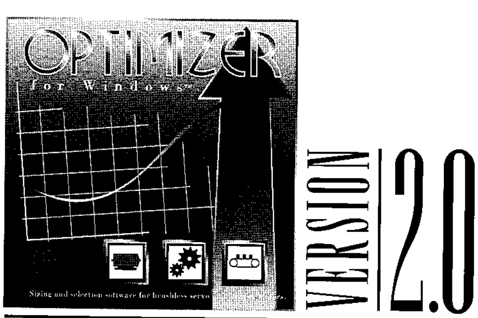
Select the proper motor using one of the following procedures.

- If you are already familiar with these motors and the available options, refer to the Model Number Codes on page 4 (NEMA 23) and page 8 (NEMA 34) to verify the coded information prior to ordering.

- If you are not familiar with these motors and the available options:
  - -refer to the General Specifications on page 3 and/or the Index at the right. Note that each frame size is covered separately and the Technical Data applies to all motors. Construct a model number after all the technical parameters, including options, are determined.
  - -Use OPTIMIZER™ Version 2.0, our Windows® compatible sizing and selection software for both brushless servo and stepper motors. Call or fax us for your free program disk. A complete model number will be selected.

Additional technical information available on request

- Motion Control Mechanics
- Sizing a Servomotor for your Application
- Optimizer – Sizing and Selection Software



Sizing and selection software for brushless servomotors and hybrid steppers. Ask for a FREE copy.

SENTRY™ SERIES BRUSHLESS SERVOMOTORS

FEATURES

- Troublefree, brushless construction
- Highest torque per frame size
- Medium rotor inertia for improved load inertia matching
- Low thermal resistance for maximum power rating per frame size
- High torque over wide speed range
- Location flexibility, with no need to provide brush maintenance access
- Reduced EMI through elimination of brushes and brush arcing
- Anti-cog magnet design for smooth low speed performance
- Rugged TENV, NEMA and IP65 construction for washdown requirements
- 2 year warranty
- High voltage insulation – contact application engineering

PRIMARY FEEDBACK OPTIONS

- Hall sensors
- Frameless resolver, transmitter type

SECONDARY FEEDBACK OPTIONS

- 1000-, and 1024-line optical incremental encoders

OTHER OPTIONS

- NEMA or metric mounting and shaft configurations
- Shaft seals
- High-speed/high-power (low torque constant) or low-speed/low-power (high torque constant) windings

PERFORMANCE

Series	Continuous stall torque–lb-in. (Nm)	Peak torque–lb-in. (Nm)
S 20, NEMA 23	up to 13.8 (1,56)	up to 41.5 (4,70)
S 30, NEMA 34	up to 45 (5,1)	up to 131 (14,8)

GENERAL SPECIFICATIONS

Number of poles 6
Winding . . . . .3 phase wye
Magnet type . . . . .Neodymium-iron-boron
Sealed housing construction (all motors) . . . . . .TENV, NEMA and IP65, See P. 24
Terminations . . . . .MS connectors, Flying Leads, Flying Leads w/ MS connectors at end, Terminal Box (NEMA 34 only)
Thermal protection . . . . .positive-temperature-coefficient (PTC) thermistor
Frame construction
S 20, NEMA 23 Series (2.28" width/height) . . .square
S 30, NEMA 34 Series (3.25" width/height) . . .square

Additional information

SENTRY™ S20 SERIES
NEMA 23 Frame
2.28" square

MODEL NUMBER CODE

To construct a motor listing, select the combination of features required and put all the coded information in the proper sequence. Please account for all entries. The model number shown is an example of a properly specified motor.

S 22 G N N A - H G N L - 00

Motor Series
S = SENTRY
6 pole Neodymium

Motors
S 21
S 22
S 24

Frame Size	Stack Length
2 = NEMA 23	1 = 1 Stack 2 = 2 Stack 4 = 4 Stack

Winding
G
H

Shaft & Mounting
N= NEMA 23 Frame
M= Metric mounting

Holding Brake Option
N= No brake
A= 24 Vdc brake
B= 100 Vdc brake

Factory Preassigned

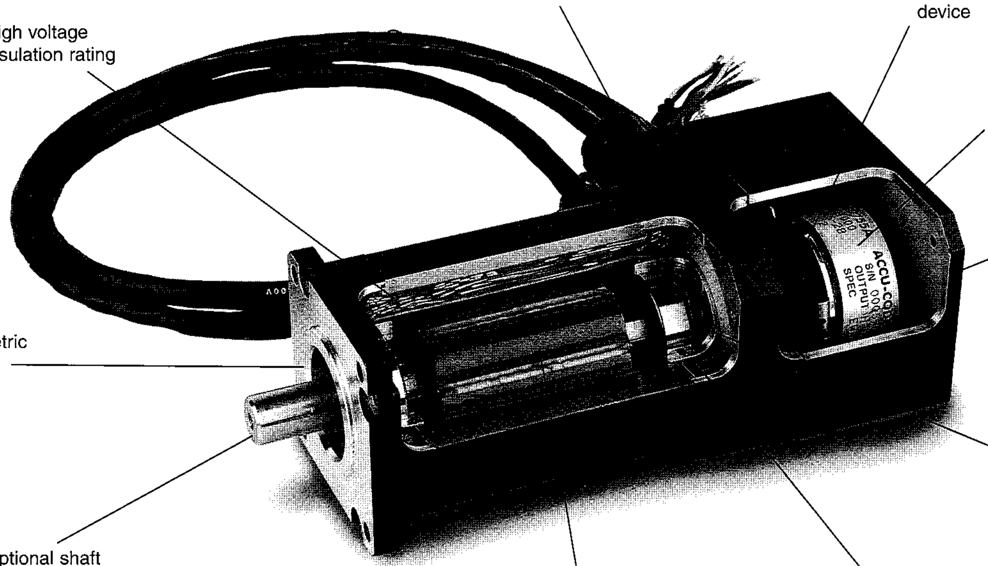
Primary Feedbacks
H= Hall Sensor
R= Size 21 frameless resolver
N= No primary

Secondary Feedbacks
(Standard encoder secondary options apply with Hall sensor primary feedback only. Contact factory for other combinations.)
F= 1000 ppr, line driver encoder
G= 1024 ppr, line driver encoder
N= no secondary

Shaft Sealing
N= No shaft seal
V= Viton shaft seal

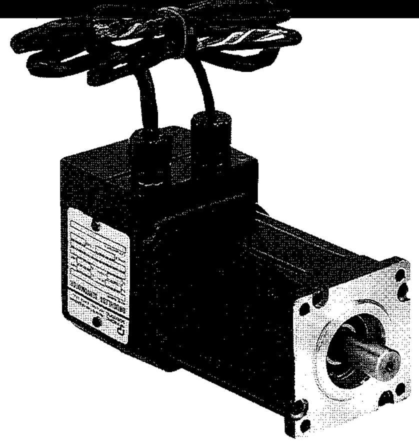
Terminations
C = 18" Flying leads with MS connectors
L = 18" Flying leads
M = Motor mounted MS connectors
5 = MS connector facing shaft
6 = MS connector facing rear

Sequence Number
00 = Standard Listing



SENTRY™ S20 SERIES
NEMA 23 Frame
2.28" square

4.3 to 13.8 lb-in. (.49 to 1.6 Nm) continuous (stall) torque; 12.3 to 41.5 lb-in. (1.39 to 4.7 Nm) peak torque



PERFORMANCE FEATURES

- 6 Pole Design
- Troublefree brushless construction
- Long life bearing system
- High energy Neodymium-iron-boron magnets for maximum torque in a small package
- Medium rotor inertia for better load matching
- Full torque over wide speed range
- Anti-cog magnet design for smooth low speed performance
- Built in thermal protection
- NEMA 23 mounting standard
- High torque per frame size

SENTRY Series brushless servomotors deliver excellent torque, speed and/or position control.

Neodymium magnets, long life bearings and brushless construction assure maximum performance and service life.

TYPICAL APPLICATIONS

- Clamping
- Coil Winders
- Electronic insertion machinery
- Fluid Metering
- Gauging
- In-Feed / Out-Feed conveyors
- Mail handling equipment
- Material handling
- Packaging machinery
- Robotics
- Test equipment
- X-Y tables

RATINGS AND CHARACTERISTICS

Motor parameters and winding data

	ENGLISH					METRIC				
Parameters	Symbol	Units	S21	S22	S24	Symbol	Units	S21	S22	S24
Continuous stall torque △1	T_{CS}	lb-in.	4.3	8.4	13.8	T_{CS}	Nm	,49	,95	1,56
Peak Torque △4	T_{PK}	lb-in.	12.3	24.3	41.5	T_{PK}	Nm	1,39	2,75	4,70
Inertia (motor only) △3	J_M	lb-in-sec^2	.000196	.000384	.000706	J_M	kgm^2 x 10^{-3}	,022	,043	,080
Static friction (max.)	T_f	lb-in.	.07	.09	.22	T_f	Nm	,008	,010	,025
Viscous Damping coefficient	K_{DV}	lb-in/Krpm	.03	.05	.11	K_{DV}	Nm/Krpm	,003	,006	,012
Thermal resistance △5	R_{TH}	°C/Watt	2.2	1.7	1.29	R_{TH}	°C/Watt	2,2	1,7	1,29
Thermal time constant	τ_{TH}	min.	5	11	15	τ_{TH}	min.	5	11	15
Weight (motor only)	W	lbs.	3.1	4.2	6.0	M (mass)	kg	1,4	1,9	2,7

Winding data	Symbol	Units	S21 G	S21 H	S22 G	S22 H	S24 G	S24 H	Symbol	Units	S21 G	S21 H	S22 G	S22 H	S24 G	S24 H
Torque Constant (line-line) △2	K_T peak	lb-in/A	2.5	1.3	5.1	2.5	5.4	2.7	K_T peak	Nm/A	,28	,14	,57	,28	,61	,31
Voltage Constant (line-line) △2	K_E peak	V/Krpm	30	15	60	30	64	32	K_E peak	V/rad/sec	,28	,14	,57	,28	,61	,31
Continuous stall current △1	I_{CS}	A	1.9	3.8	1.8	3.5	3.2	6.3	I_{CS}	A	1,9	3,8	1,8	3,5	3,2	6,3
Current at peak torque △4	I_{PK}	A	5.7	11.4	5.4	10.5	9.6	18.9	I_{PK}	A	5,7	11,4	5,4	10,5	9,6	18,9
Resistance (line-line)	R_C cold	Ohms	12.0	3.0	16.2	4.2	6.8	1.8	R_C cold	Ohms	12,0	3,0	16,2	4,2	6,8	1,8
Resistance (line-line) △1	R_H hot	Ohms	18.1	4.5	24.5	6.3	10.3	2.7	R_H hot	Ohms	18,1	4,5	24,5	6,3	10,3	2,7
Inductance (line-line)	L	mH	14.4	3.7	22.1	5.7	9.3	2.2	L	mH	14,4	3,7	22,1	5,7	9,3	2,2

Note: All values at 25°C unless otherwise noted.

△1 Windings at 155°C. Motor in 25°C ambient and mounted to a 10" x 10" x 1/4" aluminum heat sink.

△2 Peak value of a sinusoidal waveform.

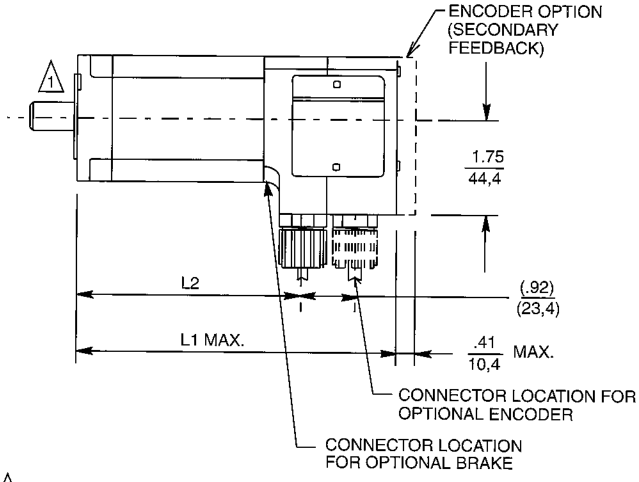
△3 Add feedback and if applicable, holding brake for total inertia.

△4 Caution: For peak torques or peak currents greater than 3X the continuous rating, consult the factory for thermal considerations.

△5 Motor in 25°C ambient mounted to a 10" x 10" x 1/4" aluminum heat sink.

DIMENSIONS . . . S20 Series, NEMA 23 Frame...metric mounting also available

See p. 16 for termination options



1 In addition to the standard options shown below, custom shaft and mounting provisions are readily available. See worksheet p. 26.

NEMA (INCHES)

MODEL NUMBER	L1 MAX.*	L2 REF.*
S21	4.88	(3.10)
S22	5.88	(4.10)
S24	7.88	(6.10)

Note: L1 includes primary feedback device.

METRIC (MILLIMETERS)

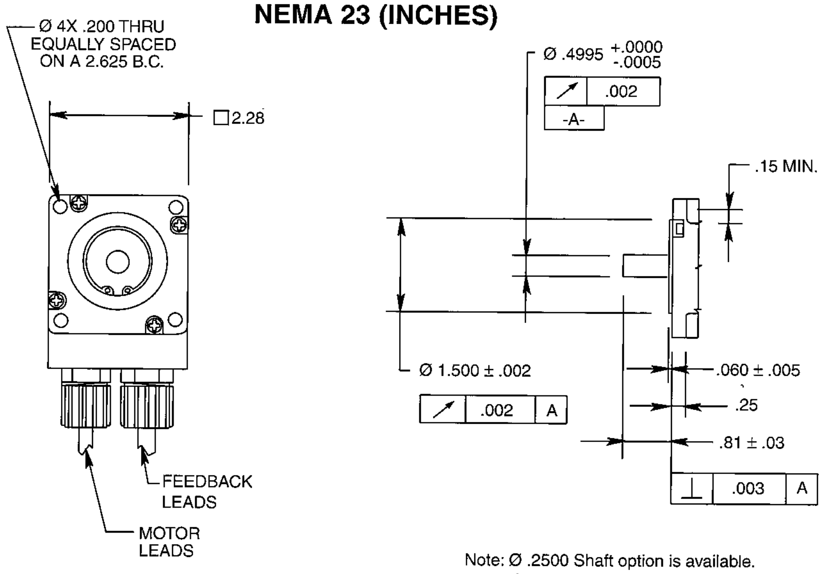
MODEL NUMBER	L1 MAX.*	L2 REF.*
S21	124,0	(78,7)
S22	149,4	(104,1)
S24	200,2	(154,9)

Note: L1 includes primary feedback device.

*Add 2.41 in. (61,2 mm) for brake option.

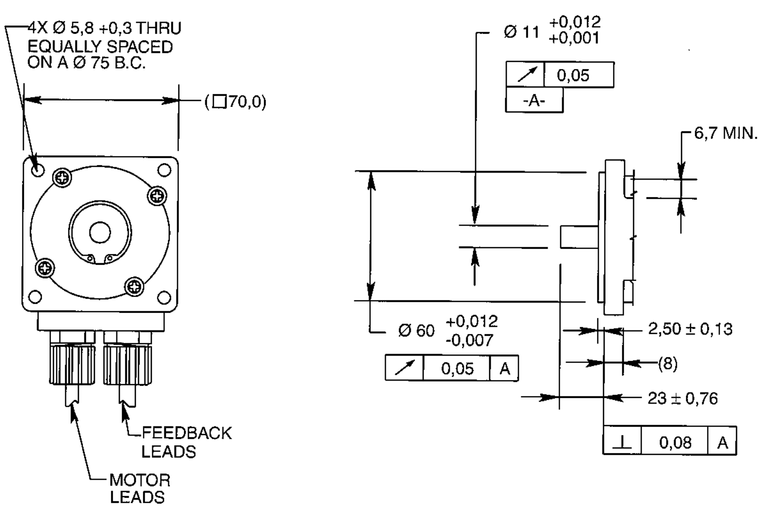
MOUNTING AND SHAFT OPTIONS

NEMA 23 (INCHES)



Note: Ø .2500 Shaft option is available. Consult application engineering.

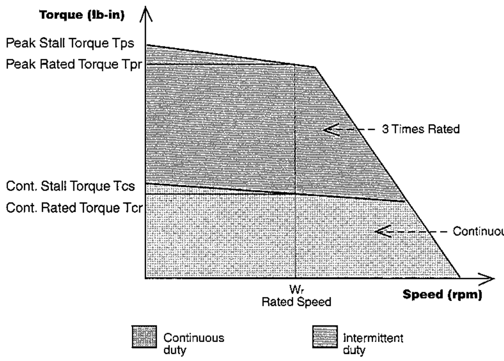
METRIC (MILLIMETERS)



SENTRY™ S20 SERIES
NEMA 23 Frame
2.28" square

Test Conditions
- Motor operated at rated winding temperature, mounted to a 10" x 10" x 1/4" Aluminum heat sink.
- 25°C. ambient
- 320 Vdc bus, trapezoidal commutation applied.

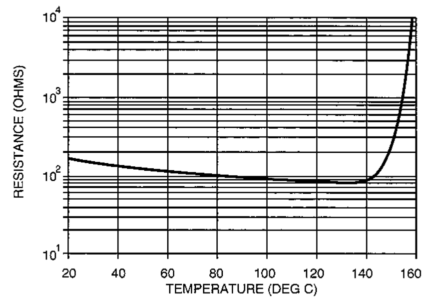
NOTE: Maximum no-load speed not to exceed 14,000 rpm. Consult Application Engineering.



The speed-torque curve example and all motor curves shown reflect peak rated torque at 3 times the motor's continuous rated torque. Motors are capable of higher peak torques. Consult brushless application engineering at (815) 226-3100.

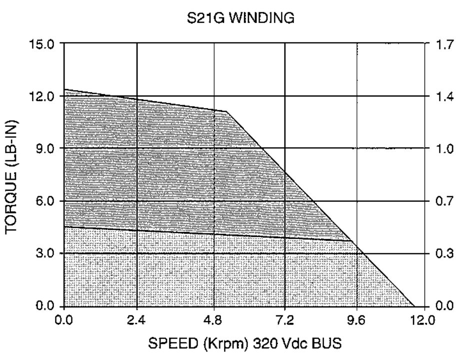
TYPICAL THERMISTOR CHARACTERISTICS, ALL MOTORS

The protective, positive-temperature-coefficient (PTC) thermistors in all motors operate with the characteristics shown here.
Caution: For peak currents or peak torques greater than 3 times continuous motor rating, consult application engineering (815) 226-3100, for thermal considerations.



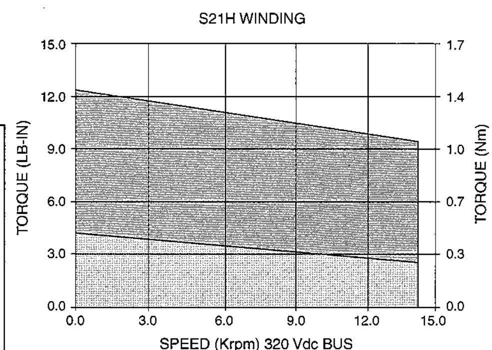
S21G MOTOR

Reference Points	
T_{PS}	12.0
T_{PR}	11.0
T_{CS}	4.3
T_{CR}	4.0
W_R	5,000
I_{cs}	1.9
I_{pk}	5.7



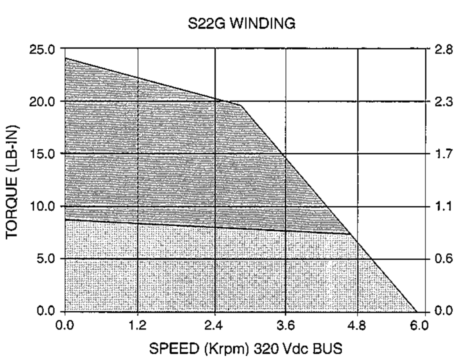
S21H MOTOR

Reference Points	
T_{PS}	12.0
T_{PR}	11.0
T_{CS}	4.3
T_{CR}	3.1
W_R	10,000
I_{cs}	3.8
I_{pk}	11.4



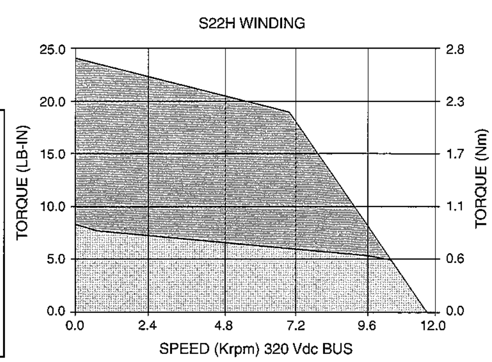
S22G MOTOR

Reference Points	
T_{PS}	24.0
T_{PR}	21.0
T_{CS}	8.4
T_{CR}	8.0
W_R	2,500
I_{cs}	1.8
I_{pk}	5.4



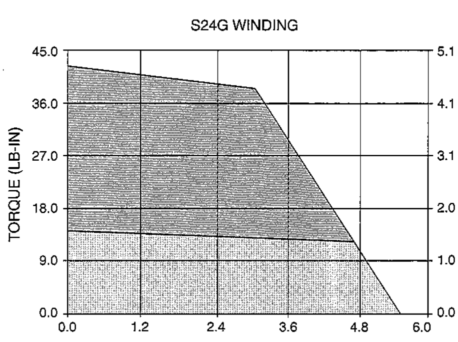
S22H MOTOR

Reference Points	
T_{PS}	24.0
T_{PR}	19.0
T_{CS}	8.4
T_{CR}	6.0
W_R	7,000
I_{cs}	3.5
I_{pk}	10.5



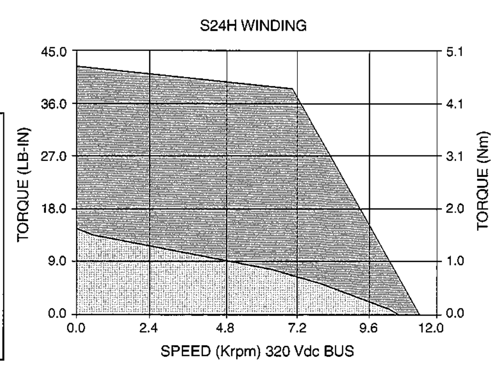
S24G MOTOR

Reference Points	
T_{PS}	42.0
T_{PR}	39.0
T_{CS}	13.8
T_{CR}	12.6
W_R	3,000
I_{cs}	3.3
I_{pk}	9.6



S24H MOTOR

Reference Points	
T_{PS}	42.0
T_{PR}	38.0
T_{CS}	13.8
T_{CR}	6.3
W_R	7,000
I_{cs}	6.3
I_{pk}	18.9



SENTRY™ S30 SERIES
NEMA 34 Frame
3.38" square

MODEL NUMBER CODE

To construct a motor listing, select the combination of features required and put all the coded information in the proper sequence. Please account for all entries. The model number shown is an example of a properly specified motor.

S 3 2 G N N A - H G N M - 0 0

Motor Series
S = SENTRY
6 pole Neodymium

Frame Size
3 = NEMA 34

Stack Length
1 = 1 Stack
2 = 2 Stack
3 = 3 Stack

Motors
S 31
S 32
S 33

Winding
G
H

Shaft & Mounting
N= NEMA 34 Frame
M= Metric mounting

Holding Brake Option
N= No brake
A= 24 Vdc brake
B= 100 Vdc brake

Factory Preassigned

Primary Feedbacks
H= Hall Sensor
R= Size 21 frameless resolver
N= No primary

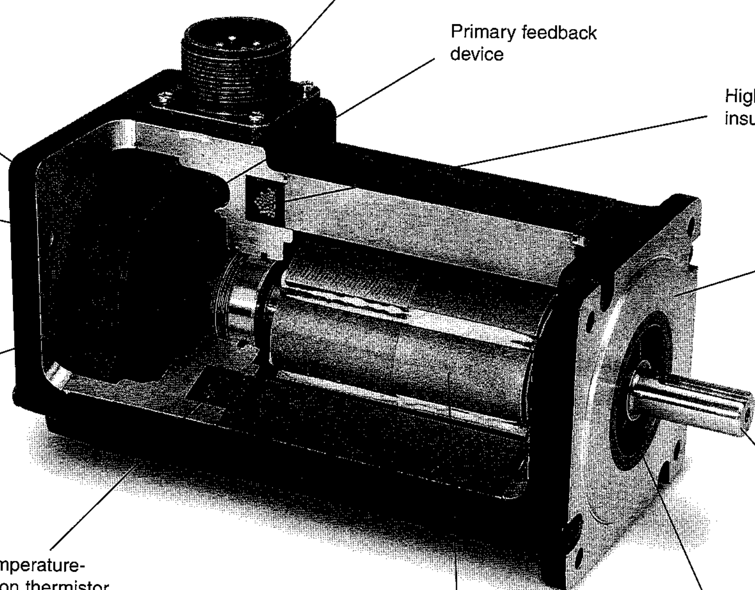
Secondary Feedbacks
(Standard encoder secondary options apply with Hall sensor primary feedback only. Contact factory for other combinations.)
F= 1000 ppr, line driver encoder
G= 1024 ppr, line driver encoder
N= no secondary

Shaft Sealing
N= No shaft seal
V= Viton shaft seal

Terminations
C= 18" Flying leads with MS connectors at end
L= 18" Flying leads
M= Motor mounted MS connectors
⚠ 1= Terminal box, feedback MS connector facing shaft
⚠ 2= Terminal box, feedback MS connector facing rear
⚠ 5= Terminal box with MS connectors facing shaft
⚠ 6= Terminal box with MS connectors facing rear

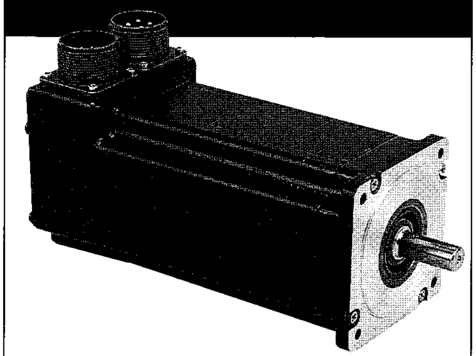
Sequence Number
00 = Standard Listing

⚠ Terminal Box options 1 & 2 have a terminal block for motor power, brake, and ground connections with a standard MS connector for feedback(s), and PTC connections with front or rear facing orientation. Terminal box options 5 & 6 provide standard MS connectors for motor power, feedback(s), PTC, and brake connections with front or rear facing orientation. See termination options beginning on p. 16.



SENTRY™ S30 SERIES
NEMA 34 Frame
3.38" square

19 to 45 lb-in. (2.2 to 5.1 Nm) continuous (stall) torque; 56 to 131 lb-in. (6.3 to 14.8 Nm) peak torque



PERFORMANCE FEATURES

- 6 Pole Design
- Troublefree brushless construction
- Long life bearing system
- High energy Neodymium-iron-boron magnets for maximum torque in a small package
- Medium rotor inertia for better load matching
- Full torque over wide speed range
- Anti-cog magnet design for smooth low speed performance
- Built in thermal protection
- NEMA 34 mounting standard
- High torque per frame size

SENTRY Series brushless servomotors deliver excellent torque, speed and/or position control.

Neodymium magnets, long life bearings and brushless construction assure maximum performance and service life.

TYPICAL APPLICATIONS

- Assembly equipment
- Coil Winders
- Electronic insertion machinery
- Machine tools
- Mail handling equipment
- Material handling
- Packaging machinery
- Press feeds
- Robotics
- Specialty test equipment
- Spindles
- X-Y tables

RATINGS AND CHARACTERISTICS

Motor parameters and winding data

	ENGLISH					METRIC				
Parameters	Symbol	Units	S31	S32	S33	Symbol	Units	S31	S32	S33
Continuous stall torque (1)	T_{CS}	lb-in.	19	34	45	T_{CS}	Nm	2,2	3,8	5,1
Peak Torque (4)	T_{PK}	lb-in.	56	99	131	T_{PK}	Nm	6,3	11,2	14,8
Inertia (motor only) (3)	J_M	lb-in-sec²	.0014	.0028	.0041	J_M	kgm² x 10⁻³	,15	,32	,46
Static friction (max.)	T_f	lb-in.	.56	1.31	1.5	T_f	Nm	,063	,150	,170
Viscous Damping coefficient	K_{DV}	lb-in/Krpm	.15	.35	.42	K_{DV}	Nm/Krpm	,016	,039	,047
Thermal resistance	R_{TH}	°C/Watt	1.23	.97	.87	R_{TH}	°C/Watt	1,23	,97	,87
Thermal time constant (5)	τ_{TH}	min.	14	24	27	τ_{TH}	min.	14	24	27
Weight (motor only)	W	lbs.	7.1	10.7	14.2	M (mass)	kg	3,2	4,9	6,5

Winding data	Symbol	Units	G	H	G	H	G	H	Symbol	Units	G	H	G	H	G	H
Torque Constant (line-line) (2)	K_T peak	lb-in/A	10.2	5.1	10.0	5.0	14.8	7.4	K_T peak	Nm/A	1,15	,58	1,13	,57	1,67	,84
Voltage Constant (line-line) (2)	K_E peak	V/Krpm	120	60	118	59	174	87	K_E peak	V/rad/sec	1,15	,58	1,13	,57	1,67	,84
Continuous stall current (1)	I_{CS}	A	2.1	4.1	3.8	7.5	3.4	6.9	I_{CS}	A	2,1	4,1	3,8	7,5	3,5	6,9
Current at peak torque (4)	I_{PK}	A	6.21	12.3	11.3	22.5	10.4	20.7	I_{PK}	A	6,2	12,3	11,3	22,5	10,4	20,7
Resistance (line-line)	R_C cold	Ohms	16.4	4.1	6.2	1.6	8.4	2.1	R_C cold	Ohms	16,4	4,1	6,2	1,6	8,4	2,1
Resistance (line-line) (1)	R_H hot	Ohms	24.4	6.1	9.2	2.3	12.8	3.2	R_H hot	Ohms	24,4	6,1	9,2	2,3	12,8	3,2
Inductance (line-line)	L	mH	41.2	10.3	18	4.5	25.2	6.3	L	mH	41,2	10,3	18	4,5	25,2	6,3

Note: All values at 25°C unless otherwise noted.

(1) Windings at 155°C. Motor in 25°C ambient and mounted to a 10" x 10" x 1/4" aluminum heat sink.

(2) Peak value of a sinusoidal waveform.

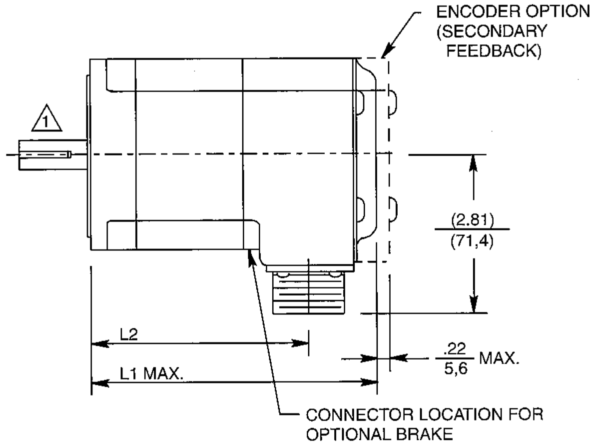
(3) Add feedback and if applicable, holding brake for total inertia.

(4) Caution: For peak torques or peak currents greater than 3X the continuous rating, consult the factory for thermal considerations.

(5) Motor in 25°C ambient mounted to a 10" x 10" x 1/4" aluminum heat sink.

DIMENSIONS . . . S30 Series, NEMA 34 Frame

See p. 16 for termination options



1 In addition to the standard options shown below, custom shaft and mounting provisions are readily available. Contact factory. See worksheet p. 26.

ENGLISH (INCHES)

MODEL NUMBER	L1 MAX.*	L2 REF.*
S31	5.13	(3.84)
S32	6.63	(5.34)
S33	8.13	(6.84)

Note: L1 includes primary feedback device.

METRIC (MILLIMETERS)

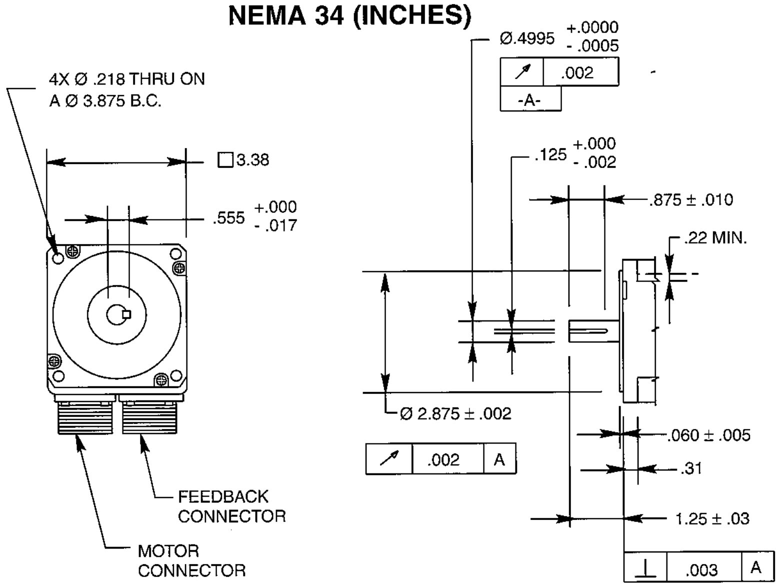
MODEL NUMBER	L1 MAX.*	L2 REF.*
S31	130,3	(97,5)
S32	168,4	(135,6)
S33	206,5	(173,7)

Note: L1 includes primary feedback device.

* Add 2.66 in. (67,5 mm) for brake option.

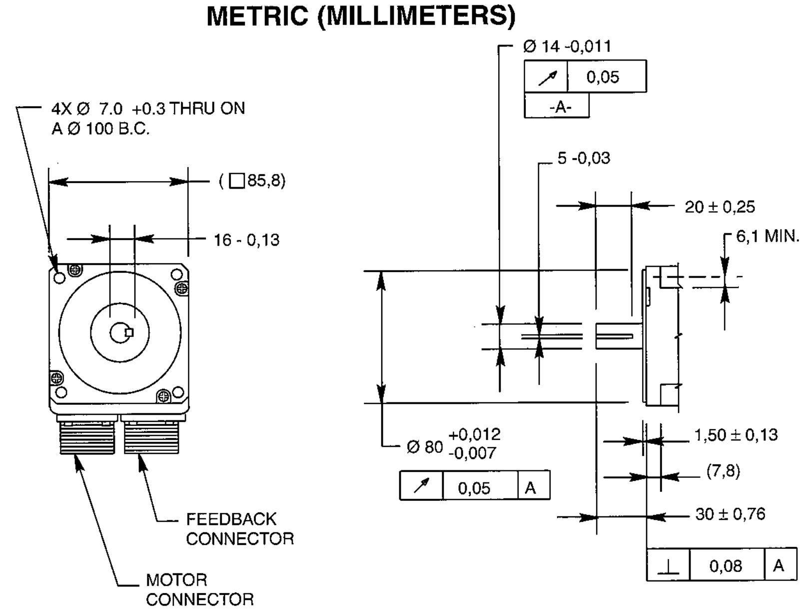
MOUNTING AND SHAFT OPTIONS

NEMA 34 (INCHES)



NOTE: .375 shaft option available consult application engineering.

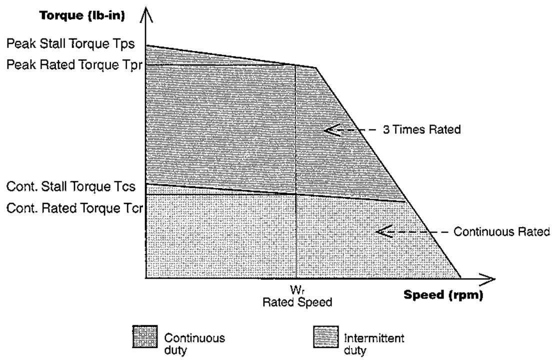
METRIC (MILLIMETERS)



SENTRY™ S30 SERIES
NEMA 34 Frame
3.38" square

Test Conditions
- Motor operated at rated winding temperature, mounted to a 10" x 10" x 1/4" Aluminum heat sink.
- 25°C ambient
- 320 Vdc bus applied

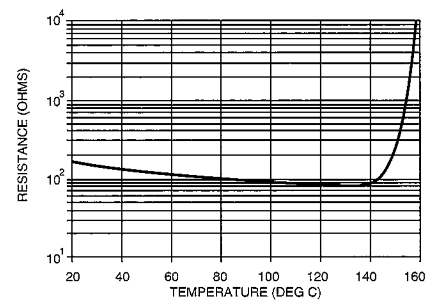
NOTE: Maximum no-load speed not to exceed 14,000 rpm. Consult Application Engineering.



The speed-torque curve example and all motor curves shown reflect peak rated torque at 3 times the motor's continuous stall current. Motors are capable of higher peak torques. Consult brushless application engineering at (815) 226-3100

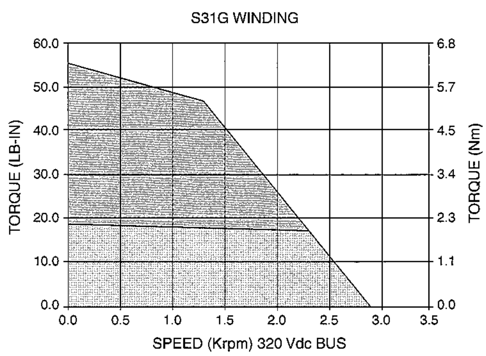
TYPICAL THERMISTOR CHARACTERISTICS, ALL MOTORS

The protective, positive-temperature-coefficient (PTC) thermistors in all motors operate with the characteristics shown here.
Caution: For peak currents or peak torques greater than 3 times continuous motor rating, consult application engineering (815) 226-3100, for thermal considerations.



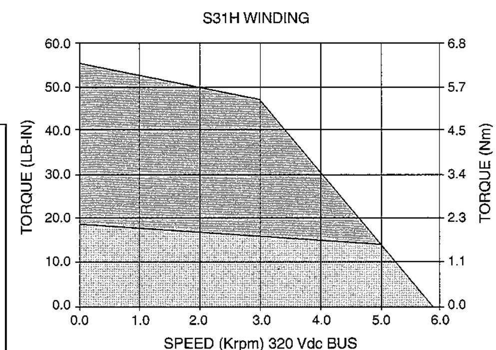
S31G MOTOR

Reference Points	
T_{PS}	56.0
T_{PR}	46.0
T_{CS}	19.0
T_{CR}	18.0
W_R	1,300
I_{cs}	2.1
I_{pk}	6.3



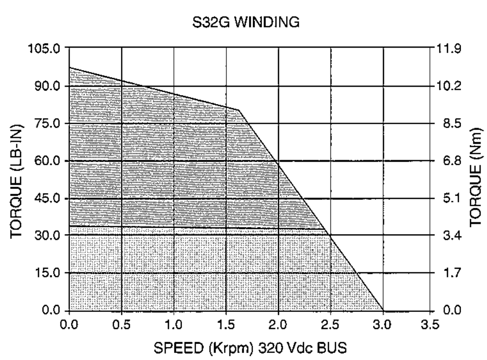
S31H MOTOR

Reference Points	
T_{PS}	56.0
T_{PR}	48.0
T_{CS}	19.0
T_{CR}	17.0
W_R	3,000
I_{cs}	4.1
I_{pk}	12.3



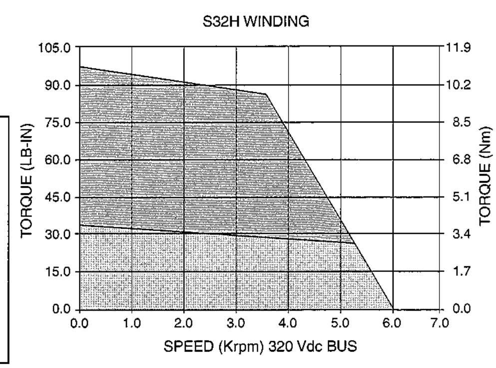
S32G MOTOR

Reference Points	
T_{PS}	99.0
T_{PR}	87.0
T_{CS}	34.0
T_{CR}	30.0
W_R	1,500
I_{cs}	3.8
I_{pk}	11.4



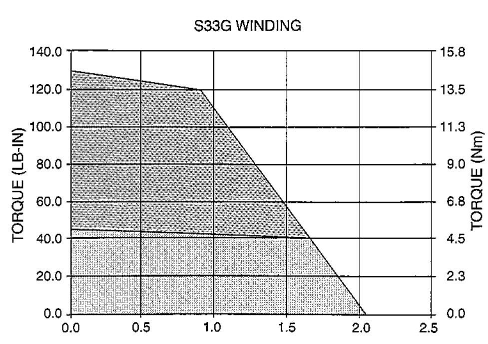
S32H MOTOR

Reference Points	
T_{PS}	99.0
T_{PR}	87.0
T_{CS}	34.0
T_{CR}	26.0
W_R	3,400
I_{cs}	7.5
I_{pk}	22.5



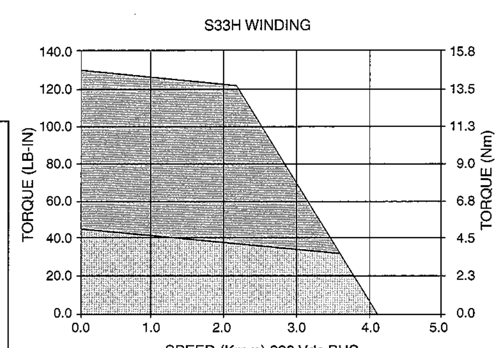
S33G MOTOR

Reference Points	
T_{PS}	131.0
T_{PR}	120.0
T_{CS}	45.0
T_{CR}	42.0
W_R	900
I_{cs}	3.4
I_{pk}	10.2



S33H MOTOR

Reference Points	
T_{PS}	131.0
T_{PR}	122.0
T_{CS}	45.0
T_{CR}	37.0
W_R	2,100
I_{cs}	6.9
I_{pk}	20.7



VOLTAGE (K_E) AND TORQUE (K_T) CONSTANTS

All Pacific Scientific motors are 3-phase WYE connected. The phase-to-phase (line-line) back EMF approximates a sinusoidal waveform. The back-EMF constant, or voltage constant, is measured while driving the motor as a generator at 1000 rpm and is expressed as a peak value. The motor's torque constant may then be calculated from the voltage constant measurement.

Two types of controls are typically used to drive the motor; either 6-step (DC or trapezoidal) or sinusoidal (AC or continuous commutation). The relationship of the motor's peak voltage constant and peak torque constant to their effective values depends on which type of drive is used.

A 6-step control puts current in 2 phases at a time, commutating every 60 electrical degrees. The amplifier current is usually specified as the DC portion of the square wave output, and the motor's effective K_T and K_E are the average values through the 60° commutation zone, or .95 x the peak values.

A sinusoidal control puts a sinusoidally varying current in all three phases. The amplifier current is usually specified as either a peak value or as an RMS value.

For a peak current specification, the motor's effective K_T is .86 x K_T peak.

For an RMS current specification, the motor's effective K_T is 1.22 x K_T peak.

The motor's K_E expressed in VRMS/KRPM is .707 x K_E peak.

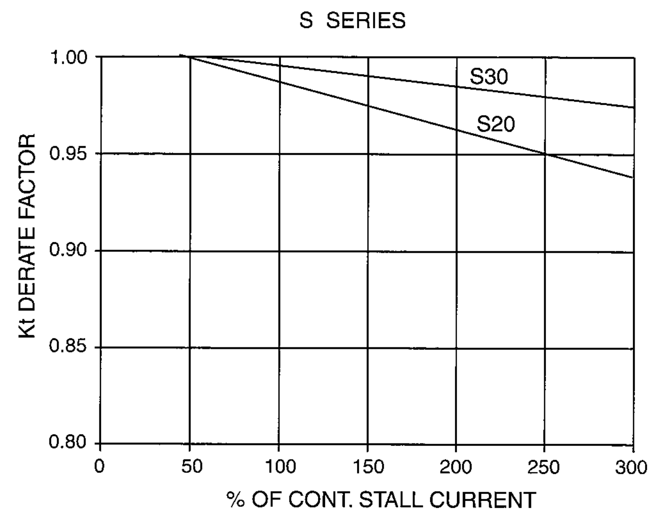
The same conversion methods apply to metric values.

TORQUE LINEARITY

Maximum Linear Torque (10% loss in K_T)

The torque/current relationship of any permanent-magnet motor changes as more current is applied. This change is the result of the degree of saturation of the motor's magnetic circuit.

At low current levels, the torque/current relationship is quite linear. As more current is applied, torque is increasingly non-linear. The maximum linear torque value is expressed at that point where torque has dropped 10% from a theoretical linear relationship. Note that additional torque can be produced beyond this point but a disproportionate amount of current must be applied.



HOLDING BRAKE

The holding brake is designed to provide a static holding torque to the motor shaft with the brake coil de-energized. The brake must first be released (coil energized) prior to commanding motor rotation as determined by its "drop-out time". **The holding brake is limited to applying holding torque to a non-rotating motor and must not be used in applications to stop a motor.**

BRAKE DATA		S20 SERIES NEMA 23 Frame		S30 SERIES NEMA 34 Frame	
Voltage Current	DC Amps	+24 .38	+100 .1	+24 .72	+100 .21
Static Holding Torque	lb-in. Nm	10 1,1	10 1,1	32 3,6	32 3,6
Inertia	lb-in-sec^2 Kgm^2 x 10^{-3}	.045 x 10^{-3} ,005	.045 x 10^{-3} ,005	.025 x 10^{-3} ,0028	.025 x 10^{-3} ,0028
Pull-in Time	msec	40	40	10	10
Drop-out Time	msec	25	25	30	30
Max Speed	RPM	5000	5000	5000	5000
Weight Adder	lbs. Kg	1.1 ,5	1.1 ,5	2.5 1,1	2.5 1,1

Notes;
1. All voltage and current values have ±10% tolerance
2. **Pull-in time** is the nominal brake engagement time.
3. **Drop-out time** is the nominal brake release time.
4. **Max. Speed** is the mechanical limiting speed of the brake.

SENTRY™ BRUSHLESS SERVOMOTOR FEEDBACK COMBINATIONS

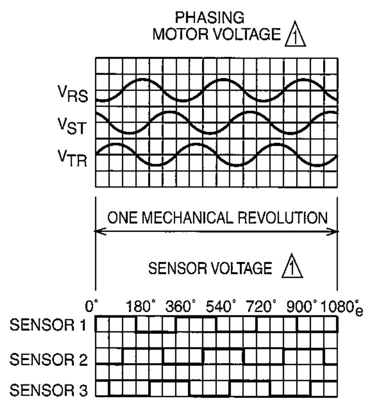
Primary Feedback Devices	Secondary Feedback Devices
Hall sensors • Commutation signals Resolver, transmitter type • Commutation signals • Analog position information • Velocity data	Digital Optical Encoders • Digital position • Velocity data

A selection of feedback configurations are available for the Sentry Series. Options include motors equipped with primary-only, primary and secondary, and secondary feedback only.

Described below are the feedback options available. Any one of the two primary feedback devices may be factory-installed by Pacific Scientific on the Sentry Series motor of your choice. The secondary-feedback device can be factory-installed on the same motor.

PRIMARY FEEDBACK DEVICES. . .TECHNICAL DATA

Hall Sensors (H) for Sentry Series

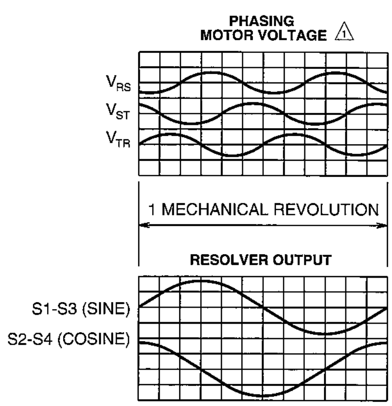


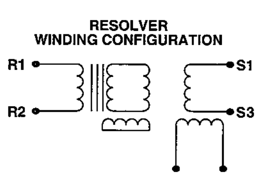
Typical output @ 25°C

Parameter	Units	Value
Commutation outputs:		See phasing diagram
No. of poles		6
No. of phases		3
Output volts, max.	volts	DC Supply
Power supply required	volts mA	+ 4.5 to 24 VDC 20 mA max
Rotor inertia	lb-in-sec^2 x 10^{-3}	.049
Weight	lb	.08

⚠ For clockwise motor rotation.

Frameless Resolvers (R)





Typical output @ 25°C

Parameter	Units	R
Frame size		21
Type		Transmitter
Primary		Rotor
Speed		1
Input voltage	V_{RMS}	4.0
Frequency	kHz	5
Input current, max.	mA	25
Transformation ratio		0.5
Max. electrical error	Minutes	±21
Rotor inertia Max.	lb-in-sec^2 x 10^{-3}	.18
Weight	lb	.56

⚠ For clockwise motor rotation.

SECONDARY FEEDBACK DEVICES...TECHNICAL DATA

Optical Encoders

Typical performance @ 25° C

S20 SERIES, NEMA 23 Frame

Parameter	F	G
Pulses per revolution	**1000**	**1024**
Type	Incremental	
Supply voltage	+5 Vdc ±5% @160 mA typical	
Output format	Dual-channel quadrature and index with complements	
Output type	26LS31 TTL Differential Line Driver (RS422A)–short-circuit protected	
Frequency response	125 kHz	
Rotor inertia	1.4 x 10^{-5} lb-in-sec^2	
Weight	.22 lbs.	

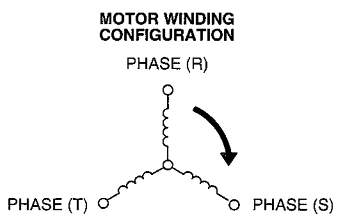
S30 SERIES, NEMA 34 Frame

Parameter	F	G
Pulses per revolution	**1000**	**1024**
Type	Incremental	
Supply voltage	+5 Vdc ±10% @165 mA typical	
Output format	Dual-channel quadrature and index with complements	
Output type	26LS31 TTL Differential Line Driver (RS422A)–short-circuit protected	
Frequency response	100 kHz	
Rotor inertia	.7 x 10^{-5} lb-in-sec^2	
Weight	.22 lbs. ⚠	

⚠ Includes weight of additional end cover.

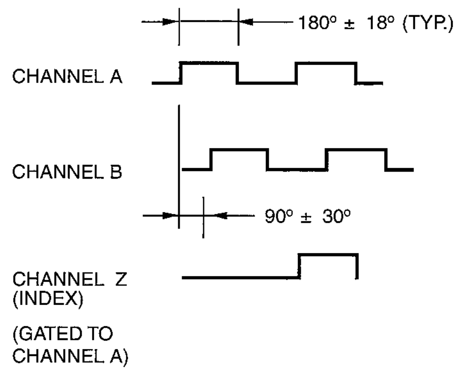
PHASING DIAGRAM—ALL MOTORS

Shown here is the phasing diagram for CW rotation as viewed from the drive-shaft end of the motor.

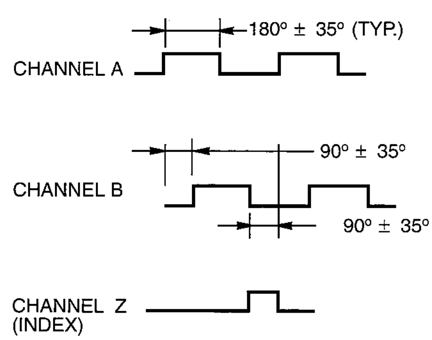


Encoder Output

FOR CW DIRECTION OF ROTATION WHEN VIEWED FROM DRIVE SHAFT END (COMPLEMENTS NOT SHOWN)



FOR CW DIRECTION OF ROTATION WHEN VIEWED FROM DRIVE SHAFT END (COMPLEMENTS NOT SHOWN)



See overview of feedback devices on the following pages.

OVERVIEW OF FEEDBACK DEVICES

A wide variety of feedback devices are used in DC servo systems and brushless servo systems. This section outlines the devices, their uses, and their merits in a brushless servo system. The tables on the following page summarize the information.

HALL-EFFECT SENSORS

Hall-effect devices are used to sense magnetic fields. They are used in some brushless servo systems to provide commutation information to the brushless servo controller.

For three phase brushless servo motors, three Hall-effect devices are used to provide commutation signals. In some motors, a magnetized wheel is attached to the rear of the motor shaft. In other motors, the actual rotor magnets are used in lieu of a magnetized wheel. The three Hall-effect devices sense the magnet field of the wheel or the rotor magnets as the motor shaft rotates and produce three square wave signals phased 120° apart. These three signals are used by the brushless controller to generate currents in the proper motor phases for optimum torque production.

The Hall-effect device itself is an electronic component and has a temperature rating of 155°C.

DC TACHOMETER (brush-type)

The DC tachometer is used to sense motor velocity. It generates an analog DC voltage that is proportional to shaft velocity. The polarity of the output voltage is determined by the direction of rotation. The tachometer can be viewed as a DC servo motor operated as a DC generator. Brushes and a commutator couple the output voltage from the rotating winding to the stationary terminal connections.

The DC tachometer is an electromagnetic device and contains no electronics.

BRUSHLESS TACHOMETER

Like the DC tachometer, this device is used to sense motor velocity. It provides an analog DC voltage proportional to speed with its polarity determined by the direction of rotation. However, unlike the DC tachometer, the brushless tachometer does not have brushes or a commutator. Commutation is done electronically which eliminates brushes and their potential problems.

The commutation electronics are typically located in the tachometer package mounted on the rear of the motor. The brushless tachometer was developed specifically for use with brushless motors.

RESOLVER

The resolver is an electromagnetic device that is excited with a high frequency carrier signal. The resolver output is a two phase, amplitude modulated signal. These signals are processed by a resolver-to-digital converter (RDC) located in the controller. There are no electronics located in the resolver package mounted on the motor.

The RDC produces an analog velocity signal and a digital position word. The digital position word is used for motor commutation and can also be used for motor positioning. The resolver is functionally equivalent to Hall-effect sensors plus brushless tachometer plus absolute encoder.

SYNCHRO

The synchro is essentially a three phase version of the resolver. Synchro signals can be processed by an RDC by first running the three phase synchro signals through a Scott-T transformer. This transformer converts the three phase signals to two phase signals which can be used by the RDC.

In industrial servo applications, the resolver is far more prevalent than the synchro. This is due primarily to the lower cost of the resolver and its ability to directly interface to the RDC electronics. Synchros require the Scott-T transformer to interface to the RDC which adds cost and complexity.

ENCODER

An encoder is an electro-optical position sensor. It is available in absolute or incremental versions with the incremental version more commonly used.

An incremental encoder consists of a glass, mylar, or metal disk with alternating opaque and transparent stripes. Light from an LED or lamp is passed through the disk onto a photosensor which detects the alternating opaque and transparent stripes. Encoder outputs are typically two phase digital signals in quadrature (90° out of phase). Rotational direction information is obtained by sensing which output phase is leading. Absolute encoders operate on similar principles but have multiple tracks to generate absolute position information.

The processing electronics used to convert the optical signals to digital signals are contained in the encoder package mounted on the motor.

COMMUTATION ENCODER

The commutation encoder is a self contained device that offers both commutation tracks for brushless motor commutation and tracks for velocity, and/or position sensing. Motor commutation is accomplished by adding additional data tracks to the encoder disk with the correct electrical spacing similar to the hall-effect feedback device. A typical commutation encoder has an additional 3 tracks which produce square waves that are phased 120° apart and can be aligned to a brushless motor's back EMF. The commutation information is used at the drive end to steer the current into the required motor winding(s). Standard encoder data tracks for velocity, and/or position found on the other tracks typically consist of square wave 2 channel quadrature with index.

The processing electronics used to convert the optical to digital signals are contained in the encoder package mounted to the motor. These devices have typically been designed to commutate 4, 6, and 8 pole motors.

OVERVIEW OF FEEDBACK DEVICES...SUMMARY

In general, it is good design practice to keep electronics and optics out of the motor since motors are designed to operate at high winding temperatures, i.e., 155°C. When the motor is operated at its rated continuous torque, the temperature around the feedback device mounted on the motor can reach 110°C or more. This temperature is well beyond the operating range of commercial and industrial grade electronic components. To solve the temperature sensitivity problem, more expensive military grade components must be used or the motor must be derated to reduce the winding temperature to an acceptable level. Either solution introduces added cost to the system.

The Hall effect, and resolver offer a solution to the temperature problem since these devices are rated to a 155°C motor winding operating temperature and their processing electronics are located in the controller rather than on the motor.

The inherent ruggedness of the Hall effect, and resolver is important when considering other environmental issues such as shock, vibration, and motor sealing. Optical encoders can be especially susceptible to these environmental hazards.

FEEDBACK DEVICES

Device	Technology	Parameter(s) Measured	Function
⚠ Hall effect	Electronic-magnetic	Coarse rotor position	Brushless motor commutation, limited velocity feedback.
DC Tachometer	Electromagnetic	Motor velocity	Analog velocity feedback.
Brushless Tachometer	Electronic	Motor velocity	Analog velocity feedback.
⚠ Resolver	Electromagnetic	Coarse rotor position, Motor velocity, Fine rotor position	Brushless motor commutation, Analog velocity feedback, Digital position feedback.
Synchro	Electromagnetic	Coarse rotor position, Motor velocity, Fine rotor position	Brushless motor commutation, Analog velocity feedback, Digital position feedback.
⚠ Encoder	Electro-optical	Fine rotor position	Digital position feedback, limited velocity feedback.

⚠ Standard Pacific Scientific Brushless Servomotor feedbacks.

STANDARD PACIFIC SCIENTIFIC SERVOMOTOR CONFIGURATIONS

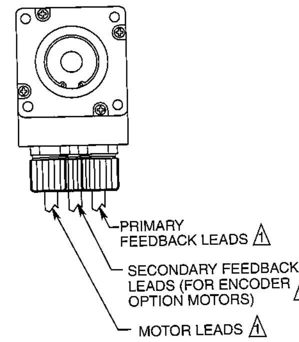
Typical Configurations	Standard Feedback Device(s) Used	Function
Torque Control	Hall effect Sensors	Sensors provide motor commutation information to an amplifier.
Velocity Control	Hall effect Sensors & Encoder	Provides motor commutation and digital velocity feedback and position information.
Position Control	Resolver	Resolver provides motor commutation, analog velocity, and digital position information to a controller (with electronics in the controller).

MOTOR CONNECTORS

FLYING LEADS (STANDARD)

(22 GA. SHIELDED CABLE, 18" LONG)

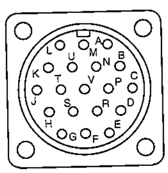
Lead Color	Function
Blue	Phase R
Brown	Phase S
Violet	Phase T
Green/Yellow	Ground (Frame)
---------	Shield



⚠ Standard length of cables is 18.0 in. (457,2 mm) minimum measured from rear end bell. Wires are stripped.

MOTOR MOUNTED MS CONNECTOR (STANDARD OPTION)

MS3102E22-14P

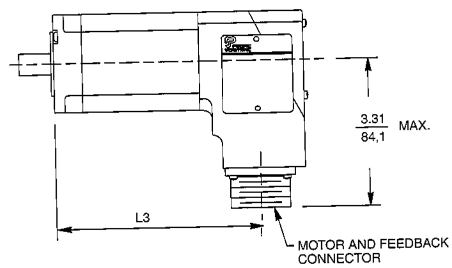


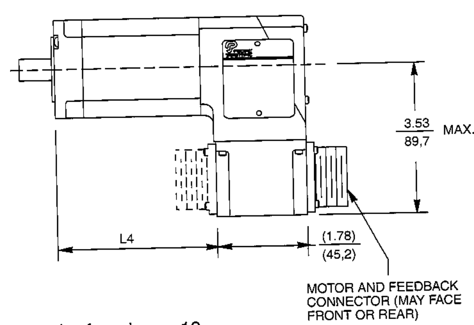
PINOUTS ⚠

Connector Pin	Function
A	Phase R
B	Phase S
C	Phase T
N	Ground (Frame)

SUGGESTED MATING CONNECTOR AND CLAMP

MATING CONNECTOR	CLAMP
MS3106A22-14S PACIFIC SCIENTIFIC P/N CZ00075	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003





ENGLISH (INCHES)

MODEL NUMBER	L3 REF.	L4 REF.
S21	(3.94)	(3.02)
S22	(4.94)	(4.02)
S24	(6.94)	(6.02)

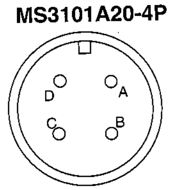
METRIC (MILLIMETERS)

MODEL NUMBER	L3 REF.	L4 REF.
S21	(100,1)	(76,7)
S22	(125,5)	(102,1)
S24	(176,3)	(152,9)

⚠ Complete Pinout information for S20 series motors can be found on p.18.

FLYING LEADS WITH MS CONNECTOR AT END (STANDARD OPTION)

MS3101A20-4P

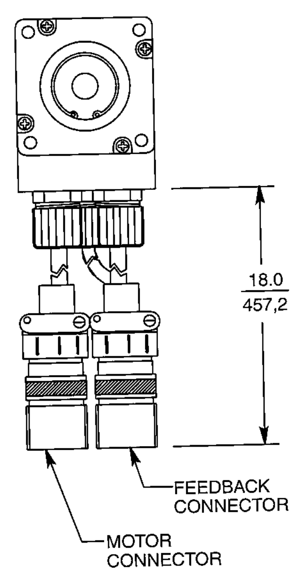


PINOUTS

Connector Pin	Function
A	Phase R
B	Phase S
C	Phase T
D	Ground (Frame)

SUGGESTED MATING CONNECTOR AND CLAMP

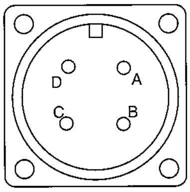
MATING CONNECTOR	CLAMP
MS3106A20-4S PACIFIC SCIENTIFIC P/N CZ00007	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003



MOTOR CONNECTORS

MOTOR MOUNTED MS CONNECTOR (STANDARD)

MS3102E20-4P

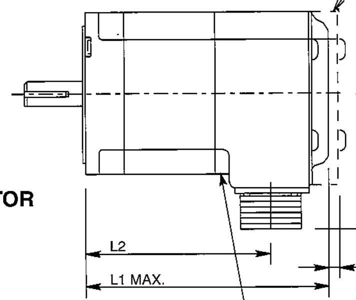


PINOUTS

Connector Pin	Function
A	Phase R
B	Phase S
C	Phase T
D	Ground (Frame)

SUGGESTED MATING CONNECTOR AND CLAMP

MATING CONNECTOR	CLAMP
MS3106A20-4S PACIFIC SCIENTIFIC P/N CZ00007	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003



ENGLISH (INCHES)

MODEL NUMBER	L1 MAX.*	L2 REF.*
S31	5.13	(3.84)
S32	6.63	(5.34)
S33	8.13	(6.84)

Note: L1 includes primary feedback device.

METRIC (MILLIMETERS)

MODEL NUMBER	L1 MAX.*	L2 REF.*
S31	130,3	(97,5)
S32	168,4	(135,6)
S33	206,5	(173,7)

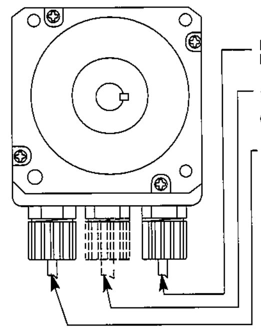
Note: L1 includes primary feedback device.

*Add 2.66 in. (67,5mm) for brake option.

FLYING LEADS (STANDARD OPTION)

(18 GA. SHIELDED CABLE, 18" LONG)

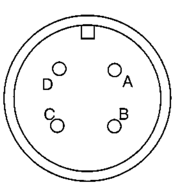
Lead Color	Function
Blue	Phase R
Brown	Phase S
Violet	Phase T
Green/Yellow	Ground (Frame)
--------	Shield



1 Standard length of flying leads is 18.0 in. (457,2 mm) minimum measured from rear end bell. Wires are stripped.

FLYING LEADS WITH MS CONNECTOR AT END (STANDARD OPTION)

MS3101A20-4P

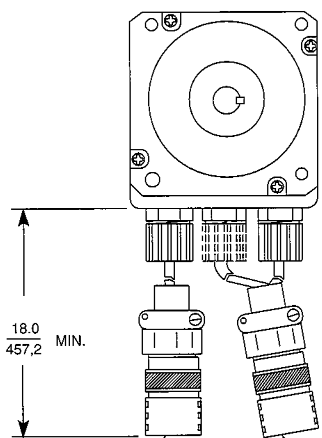


PINOUTS

Connector Pin	Function
A	Phase R
B	Phase S
C	Phase T
D	Ground (Frame)

SUGGESTED MATING CONNECTOR AND CLAMP

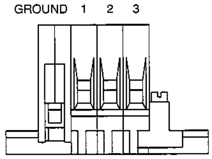
MATING CONNECTOR	CLAMP
MS3106A20-4S PACIFIC SCIENTIFIC P/N CZ00007	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003



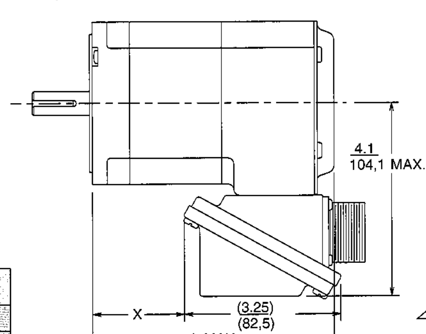
TERMINAL BOX (STANDARD OPTION)

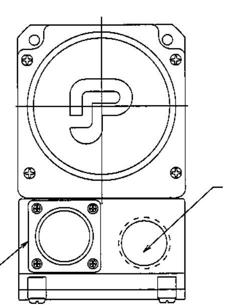
(terminal strip shown)

Available in combination with MS connector only (not flying leads) when MS connector is used for primary or primary and secondary feedback termination.



Screw Terminal Connections	Function
1	Phase R
2	Phase S
3	Phase T
⏚	Ground



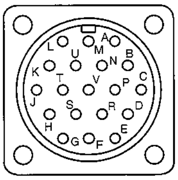


MODEL NUMBER	L MAX.	X
S31	5.13	(1.91 / 48,5)
S32	6.63	(3.41 / 86,6)
S33	8.13	(4.91 / 124,7)

PRIMARY FEEDBACK

MOTOR MOUNTED MS CONNECTOR (S20 SERIES)

MS3102E22-14P



STANDARD PINOUTS

Connector Pin	Motor and Resolver Feedback	Motor and Hall Sensor Feedback
A	Phase R	Phase R
B	Phase S	Phase S
C	Phase T	Phase T
D	N/C	N/C
E	S4 (-cosine)	Sensor 1
F	S3 (-sine)	Sensor 2
G	S2 (+cosine)	Sensor 3
H	S1 (+sine)	N/C
J	N/C	N/C
K	Thermistor ⚠	Thermistor ⚠
L	Thermistor ⚠	Thermistor ⚠
M	N/C	N/C
N	Ground (Frame)	Ground (Frame)
P	N/C	N/C
R	R1 (Excitation)	+Vdc
S	R2 (Excitation RTN)	Vdc RTN
T	N/C	N/C
U	N/C	N/C
V	N/C	N/C

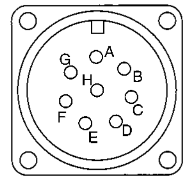
⚠ Optional Thermostat available for S 30 series only.

SUGGESTED MATING CONNECTOR AND CLAMP

MATING CONNECTOR	CLAMP
MS3106A22-14S PACIFIC SCIENTIFIC P/N CZ00075	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003

MOTOR MOUNTED MS CONNECTOR (S30 SERIES)

MS3102E20-7P



PINOUTS

Connector Pin	Resolver	Hall Sensors
A	S4 (-cosine)	+Vdc
B	S3 (-sine)	Vdc RTN
C	S2 (+ cosine)	Sensor 1
D	S1 (+sine)	Sensor 2
E	R1 (Excitation)	Sensor 3
F	R2 (Excitation RTN)	N/C
G	Thermistor	Thermistor
H	Thermistor	Thermistor

SUGGESTED MATING CONNECTOR AND CLAMP

CONNECTOR	CLAMP
MS3106A20-7S PACIFIC SCIENTIFIC P/N CZ00008	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003

FLYING LEADS (S20 & S30 SERIES)

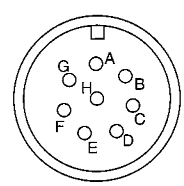
(22 GA. SHIELDED CABLE, 18" LONG)

Lead Color	Resolver	Hall Sensors
Green	S4 (-cosine)	Sensor 1
Black	S3 (-sine)	Supply Return
Brown	S2 (+cosine)	Sensor 2
Red	S1 (+sine)	+4.5 to 24 Vdc
Red/White	R1 (Excitation)	N/C
Black/White	R2 (Excitation Return)	N/C
Yellow	Thermistor	Thermistor
Blue	Thermistor	Thermistor
Yellow ⚠	N/C	Sensor 3
--------	Shields	Shields

⚠ Yellow conductor from the brown, yellow and green triad.

FLYING LEADS W/ MS CONNECTOR AT END (S20 & S30 SERIES)

MS3101A20-7P



PINOUTS

Connector Pin	Resolver	Hall Sensors
A	S4 (-cosine)	+Vdc
B	S3 (-sine)	Vdc RTN
C	S2 (+ cosine)	Sensor 1
D	S1 (+sine)	Sensor 2
E	R1 (Excitation)	Sensor 3
F	R2 (Excitation RTN)	N/C
G	Thermistor	Thermistor
H	Thermistor	Thermistor

SUGGESTED MATING CONNECTOR AND CLAMP

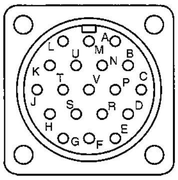
CONNECTOR	CLAMP
MS3106A20-7S PACIFIC SCIENTIFIC P/N CZ00008	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003

STANDARD TERMINATION OPTIONS...S20 & S30 SERIES

PRIMARY & SECONDARY FEEDBACK CONNECTORS

MS CONNECTOR (S20 SERIES)

MS3102E22-14P △3



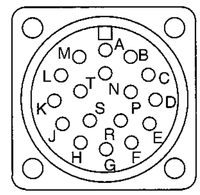
STANDARD PINOUTS

Connector Pin	△2 Motor and Hall Sensor w/ Encoder
A	Phase R
B	Phase S
C	Phase T
D	Encoder A
E	Sensor 1
F	Sensor 2
G	Sensor 3
H	Encoder + Vdc
J	Encoder + Vdc RTN
K	Thermistor △1
L	Thermistor △1
M	Encoder $\overline{A}$
N	Ground (Frame)
P	Encoder B
R	+Vdc
S	Vdc RTN
T	Encoder $\overline{B}$
U	Encoder Z
V	Encoder $\overline{Z}$

△1 Optional Thermostat available for S 30 series only.
△2 Standard Encoder available w/Hall sensor primary only.
△3 Reference Pg 19 for mating connector

MOTOR MOUNTED MS CONNECTOR (S30 SERIES)

MS3102E20-29P



PINOUTS

Connector Pin	Primary Feedback Hall Sensors	Secondary Feedback Encoder △2
A	+Vdc	
B	Supply return	
C	Sensor 1	
D	Sensor 2	
E	Sensor 3	
F	Thermistor △1	
G		Encoder A
H		Encoder $\overline{A}$
J		Encoder B
K		Encoder $\overline{B}$
L		Encoder Z
M		Encoder $\overline{Z}$
N	N/C	N/C
P	N/C	N/C
R	Thermistor △1	
S		Encoder +Vdc
T		Encoder Supply return

SUGGESTED MATING CONNECTOR AND CLAMP

MATING CONNECTOR	CLAMP
MS3106A20-29S PACIFIC SCIENTIFIC P/N CZ00009	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003

FLYING LEADS (S20 & S30 SERIES)

(22 GA. SHIELDED CABLE, 18" LONG)

Lead Color	Primary Feedback △2 Resolver	Primary Feedback △2 Hall Sensors	Secondary Feedback △2 Encoder △3
Green	S4 (-cosine)	Sensor 1	Channel Z(Index)
Black	S3 (-sine)	Supply Return	Supply Return
Brown	S2 (+cosine)	Sensor 2	Channel $\overline{Z}$
Red	S1 (+sine)	+4.5 to 24 Vdc	+5 Vdc
Red/White	R1 (Excitation)	N/C	Channel A
Black/White	R2 (Excitation Return)	N/C	Channel $\overline{A}$
Yellow	Thermistor	Thermistor	Channel B
Blue	Thermistor	Thermistor	Channel $\overline{B}$
Yellow △1	N/C	Sensor 3	N/C
--------	Shields	Shields	Shields

△1 Yellow conductor from the brown, yellow and green triad.

△2 Primary and secondary leads exit from separate locations.

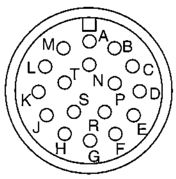
△3 Standard Encoder available w/Hall sensor primary only.

STANDARD TERMINATION OPTIONS...S20 & S30 SERIES

PRIMARY & SECONDARY FEEDBACK CONNECTORS (CONT.)

FLYING LEADS W/ MS CONNECTOR AT END (S20 & S30 SERIES)

MS3101A20-29P



PINOUTS

Connector Pin	Primary Feedback Hall Sensors	Secondary Feedback Encoder △2
A	+Vdc	
B	Supply return	
C	Sensor 1	
D	Sensor 2	
E	Sensor 3	
F	Thermistor △1	
G		Encoder A
H		Encoder $\overline{A}$
J		Encoder B
K		Encoder $\overline{B}$
L		Encoder Z
M		Encoder $\overline{Z}$
N	N/C	N/C
P	N/C	N/C
R	Thermistor △1	
S		Encoder +Vdc
T		Encoder Supply return

△1 Optional Thermostat available for S30 series only.
△2 Standard Encoder available w/Hall sensor primary only.

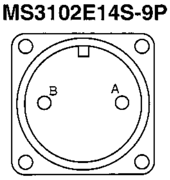
SUGGESTED MATING CONNECTOR AND CLAMP

MATING CONNECTOR	CLAMP
MS3106A20-29S PACIFIC SCIENTIFIC P/N CZ00009	MS3057-12A-1 PACIFIC SCIENTIFIC P/N CE00003

BRAKE...S20 & S30 SERIES

MOTOR MOUNTED MS CONNECTOR

MS3102E14S-9P



PINOUTS

Connector Pin	Function
A	+Vdc
B	Vdc RTN

SUGGESTED MATING CONNECTOR AND CLAMP

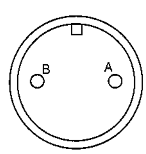
CONNECTOR	CLAMP
MS3106A14S-9S PACIFIC SCIENTIFIC P/N CZ00011	MS3057-6A-1 PACIFIC SCIENTIFIC P/N CE00005

FLYING LEADS
(18 GA. SHIELDED CABLE, 18" LONG)

Lead Color	Function
Red	+Vdc
Black	Vdc RTN

FLYING LEADS W/ MS CONNECTOR AT END

MS3101A14S-9P



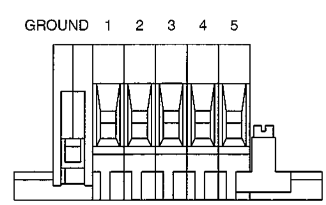
PINOUTS

Connector Pin	Function
A	+Vdc
B	Vdc RTN

SUGGESTED MATING CONNECTOR AND CLAMP

CONNECTOR	CLAMP
MS3106A14S-9S PACIFIC SCIENTIFIC P/N CZ00011	MS3057-6A-1 PACIFIC SCIENTIFIC P/N CE00005

TERMINAL BOX
(terminal strip shown)
(S30, NEMA 34 Frame only)



Screw Terminal Connections	Function
1	Phase R
2	Phase S
3	Phase T
4	Brake + Vdc
5	Brake Supply Return
⏚	Ground

PERFORMANCE OVERVIEW

The performance characteristics of a brushless servosystem (motor/controller combination) are described by a torque/speed operating envelope. As shown below, the shaded areas of the curve indicate the continuous duty and intermittent duty zones of the system.

CONTINUOUS DUTY ZONE

The continuous duty zone is bordered by the maximum continuous torque line and the system voltage line.

The continuous torque line is set by the motor's maximum rated temperature. The system voltage line is set by the voltage rating of the controller, the line voltage supplied, and the motor winding.

The system can operate on a continuous basis anywhere within this area, assuming the motor ambient temperature is 25°C or less and the motor is mounted to the specified heat sink.

INTERMITTENT DUTY ZONE

The intermittent duty zone is bordered by a peak torque line and a maximum speed line. The peak torque line for a given motor is a function of the peak current available from the drive, and the maximum speed line is a function of the bus voltage provided by the drive.

The speed-torque curves and the rating points shown illustrate system performance for motors with typically matched drives. Peak current available from the drive is typically 2 or more times the motor rated current, and the bus voltage is 320 Vdc. They are provided as references for use in comparing and sizing systems.

HIGH PEAK TORQUES MOVE LOADS FASTER!

For the purpose of conveying performance data, the peak rated torque is shown as approximately two times continuous rated torque (below and in the individual motor torque-speed curves). This is the result of typical servo drive ratings where their peak current capability is in the order of two times the continuous currents. The motor itself, however, is capable of handling much higher peak currents (without demagnetization) and therefore much higher torques can be realized on an intermittent basis provided the thermal capacity of the motor is not exceeded. This capability should be considered if it is desirable to significantly decrease the time required to accelerate a load.

As shown in the figure below, up to five times the continuous torque is possible when a drive with high peak current capability is used. However, operation in these higher zones must be limited to a duty cycle which produces an RMS torque falling within the continuous zone of a selected motor.

HIGH PEAK TORQUES MOVE LOADS FASTER! (CON'T)

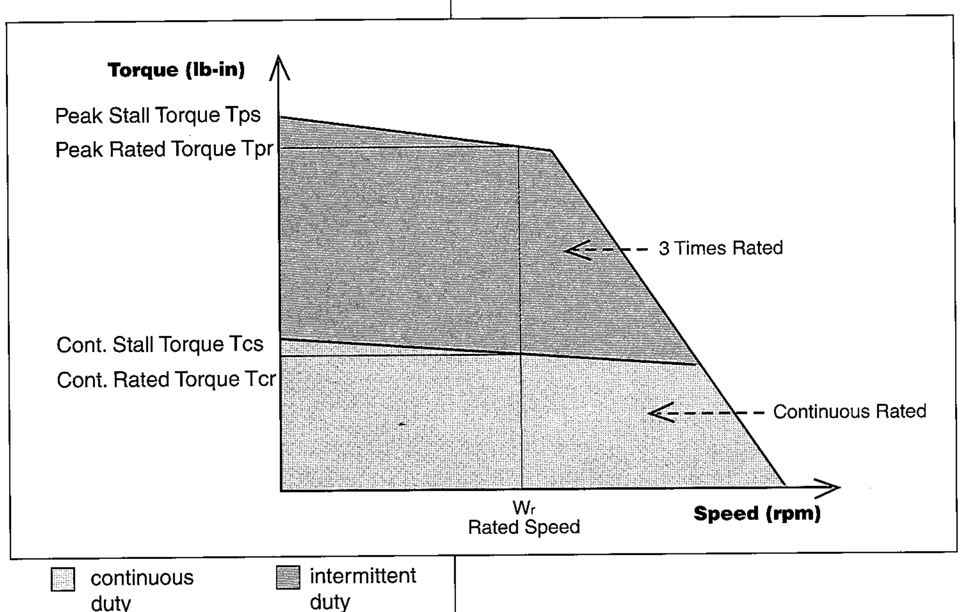
Applications requiring peak torques greater than twice the selected motor's continuous torque rating are frequently approached by electing to use a drive that can supply peak current greater than twice the rated motor current. ***Caution: If the peak torque or current requirements exceed 3 times the selected motor's continuous rating, it is very important that our application engineers be consulted, (815) 226-3100, to ensure that the thermal limitations of the motor will not be exceeded.***

ADDITIONAL REFERENCES

In addition to rating points for peak (T_{PS}) and continuous torque (T_{CS}) ratings at stall, each curve has:

Rated speed (W_R)
Continuous torque at rated speed (T_{CR})
Peak torque at rated speed (T_{PR})

These points are provided as references for use in comparing and sizing systems.



SENTRY™ SERIES BEARINGS

LONG-LIFE BEARING SYSTEM—BRUSHLESS SERVOMOTORS

All standard construction Brushless Motors include a long-life bearing system. This consists of the following:

- Captured Bearing In Front Endbell
  There is a shoulder on one side of the bearing in the front endbell to support the outer race of the bearing. The other side of the bearing's outer race is held by either a beveled or bowed retaining ring. This pushes the bearing back into the shoulder and minimizes any axial movement.

- No Slip Rear Bearing
  A groove is machined into the bearing bore in the rear endbell along the centerline of the bearing. A Viton O-ring is placed into the groove prior to inserting the rear bearing. The O-ring prevents rotation of the rear bearing outer race that might occur due to thermal expansion.

After the rear bearing is assembled, preload is added behind the rear bearing. The preload force is controlled by the design of the preload washer within bearing manufacturers' recommendations.

- Steel Bearing Insert (S30 Series)
  A steel bearing insert is cast into the front endbell. This is slightly larger than the bearing and fully surrounds the bearing and retaining ring. This further ensures that the outer race of the front bearing will not slip by eliminating the thermal expansion variable. Now, instead of a steel bearing in an aluminum casting, the bearing is surrounded by steel.

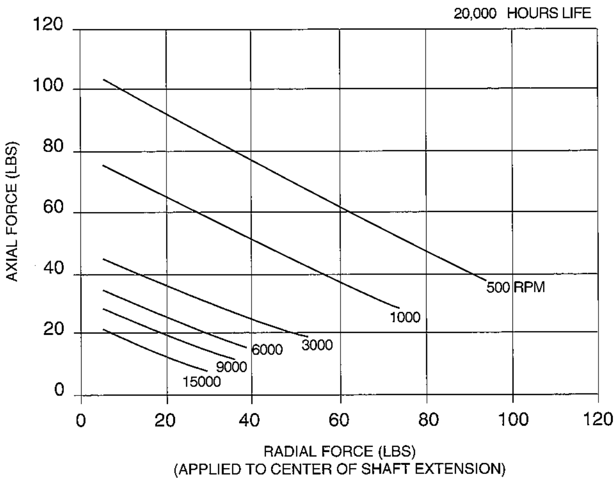
Additional information

PAGE

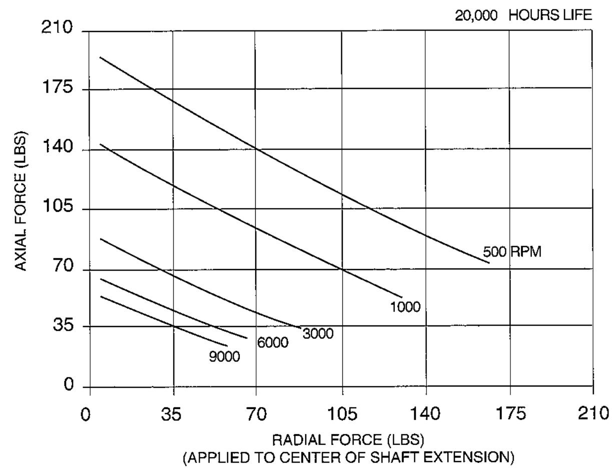
BEARING FATIGUE LIFE (L_{10})

The curves shown here depict worst-case bearing life for each Pacific Scientific brushless servomotor series.

S20 SERIES, NEMA 23 Frame (Same for metric mounting)



S30 SERIES, NEMA 34 Frame (Same for metric mounting)



SEALING OF BRUSHLESS SERVOMOTORS

ALL BRUSHLESS SERVOMOTORS ARE TENV CONSTRUCTION, NEMA AND IEC IP65 WASHDOWN RATED.
EXACTLY WHAT DOES THIS MEAN FOR PACIFIC SCIENTIFIC BRUSHLESS SERVOMOTORS?

NEMA (National Electrical Manufacturers Association) and **IEC** (International Electrotechnical Commission) are two organizations that establish and publish mechanical and electrical standards for motors. While their terminology may be different, many of the standards are very similar. In some areas, NEMA allows more room for interpretation, and IEC standards are much more specific and categorized. Both are included to the right.

TENV - (NEMA) Totally Enclosed Non-Ventilated
IC40 - (IEC) (Equivalent to TENV)

- 0 — Convection Only (No fanning action)
- 4 — Frame Surface Cooling
- IC — Cooling Type

IP65 - (IEC)

- 5 — Protection against water sprayed from a nozzle in any direction.
- 6 — Complete protection against contact with live or moving parts inside the enclosure.
- IP — Ingress Protected

How is this achieved for Pacific Scientific Brushless Servomotors?

Standard Square Motors:

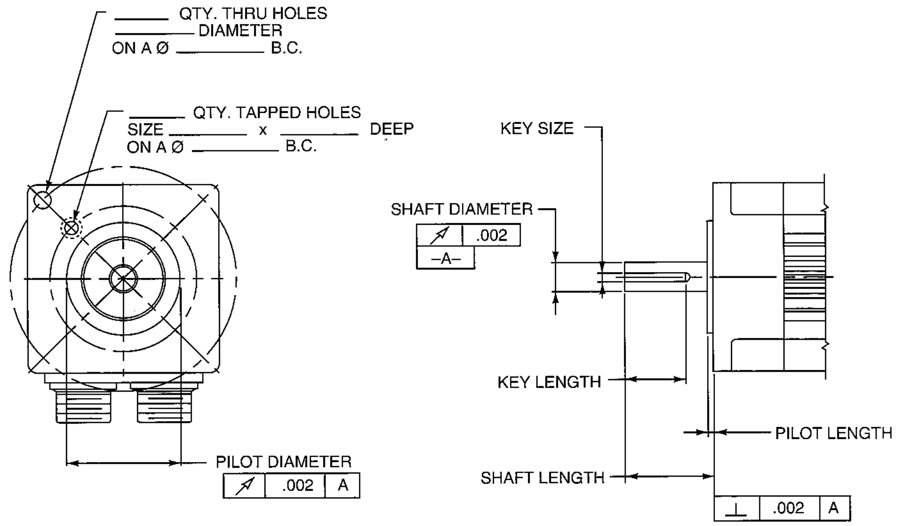
- Joints (Endbells to Housing) are sealed with an O-Ring.
- Covers are sealed with a gasket that matches the profile of the Rear Endbell/Cover flange (S20) or with an O-Ring (S30).
- MS Connector housings are sealed with an O-Ring
- MS Connectors are Type E (environmentally sealed).
- Optional Shaft Seal
- Flying lead options exit through seal-tight bushings. The bushing threads are sealed with a liquid gasket material.

All Motors

- All sealing O-Rings are Buna-N (Nitrile)
- All gasket materials for covers are a combination of Cellulose Fiber-Synthetic Rubber
- Shaft seal (OPTIONAL-designated with "VS") is Viton

If special sealing is required, consult factory.

SPECIAL MOUNTING WORKSHEET FOR BRUSHLESS SERVOMOTORS



FAX to 815-226-3148
Pacific Scientific
Application Engineering Dept.

Company____ Date ______________

Address ____

City ______________________________ State ____________ Zip ____________

Name ______________________ Title ______________ Phone ____________

Product Description ____

____

SIMILAR TO STD. MOTOR____________________

PILOT

Diameter & Tolerance________________

Length ________________

SHAFT

Diameter & Tolerance ________________

Length________________

KEY (PER DRAWING ABOVE)

Size____________ x ____________

Length________________

THRU HOLES (SKETCH LOCATION ABOVE)

Qty________________

Size ________________

Bolt Circle________________

TAPPED HOLES (SKETCH LOCATION ABOVE)

Qty ________________

Size________________

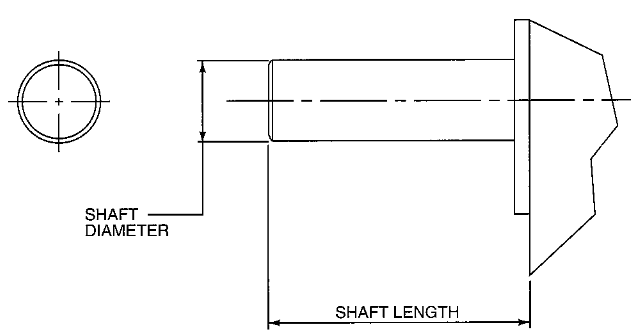
Depth

REMARKS________________

____

____

IF ALTERNATE SHAFT FEATURES ARE REQUIRED, SKETCH BELOW.



PACIFIC SCIENTIFIC
AUTOMATION TECHNOLOGY GROUP

MOTOR PRODUCTS DIVISION

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P.O. Box 106
Rockford, IL 61105-0106
(815) 226-3100
Fax (815) 226-3080

WIRING, GROUNDING, AND SHIELDING TECHNIQUES

Proper wiring, grounding, and shielding techniques are important in obtaining proper servo operation and performance. Incorrect wiring, grounding, or shielding can cause erratic servo performance or even a complete lack of operation. This section summarizes the proper techniques and is intended as a supplement to the information obtained from an amplifiers instruction manual.

MOTOR POWER WIRING (SEE FIGURE 1)

Pacific Scientific motors are three phase and hence have three terminals. These three motor terminals are labeled R, S, and T. It is imperative that the R, S, and T motor terminals be connected to the respective R, S, and T outputs of the controller. Improper phasing of these terminals will result in erratic motor operation including "deadspots," runaway, or stall.

Another important aspect of motor wiring is grounding of the motor. There is capacitive coupling between the motor's three phase winding and the motor's case. When PWM voltages are applied to the motor terminals, the motor case tends to follow these voltages because of the coupling capacitance. If the motor is not grounded, Fig. 1a, a shock hazard is present because of capacitively coupled voltage on the motor case. Therefore, motor wiring should be viewed as a four wire connection rather than a three wire connection with the fourth wire being motor ground as shown in 1b. The motor must be properly grounded to insure proper operation and to prevent shock hazard.

When the motor is grounded, pulses of current flow in the ground wire due to the motor's winding-case capacitance. These pulses are short in duration and occur at the PWM frequency. Electrical noise due to these pulses can be radiated if proper techniques are not used. To prevent radiated noise, the motor ground wire should be tightly bundled or twisted with the three wires connected to the motor terminals as shown in 1c. This will typically reduce radiated noise to an acceptable level.

If desired or required, two other techniques can be applied to attenuate noise further. Both techniques are shown in 1d. The first is shielding the four motor wires. The shield should be connected at the controller end only. As a general rule a shield should only be connected at one end to prevent ground loops. The second technique is the insertion of a common mode choke in the three wires connecting the motor terminals to the controller. This common mode choke is simply 10 turns of each motor terminal wire on a Ferroxcube 500T600-3C8 ferrite toroidal core. This choke acts to reduce the amplitude of the current pulses flowing in the motor ground wire.

As a general rule, the motor wiring should be kept as far away as possible from the feedback transducer wiring and any other signal level wiring. In addition, all signal level wiring should be done using shielded cable to reduce the risk of noise problems.

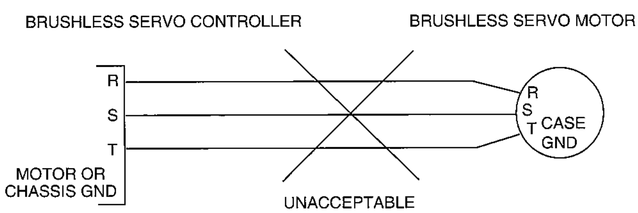

Figure 1a

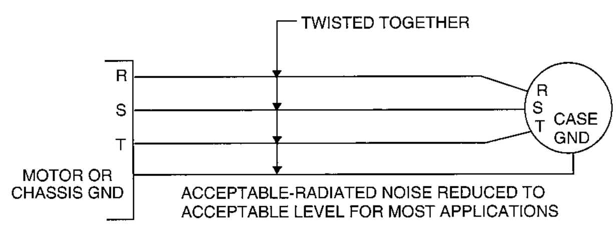

Figure 1c

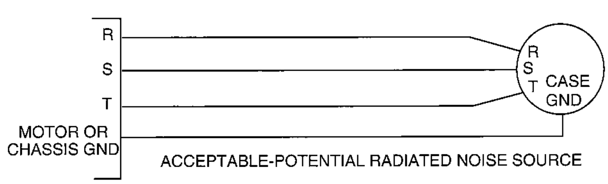

Figure 1b

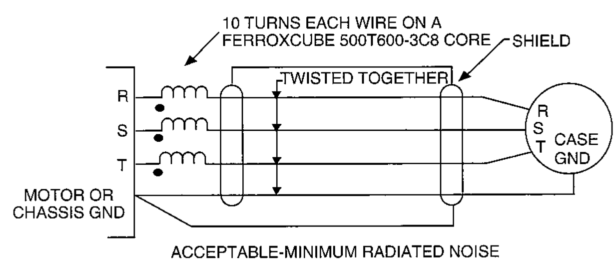

Figure 1d

MOTOR WIRING (FIGURE 1)

WIRING, GROUNDING, AND SHIELDING TECHNIQUES CONT.

FEEDBACK TRANSDUCER WIRING

Pacific Scientific SENTRY brushless servomotors use two standard primary feedback devices. For a torque only control system, Hall-effect devices are used. These devices provide motor commutation information to a brushless servo amplifier. For position control systems and some velocity control systems a resolver is used. This device provides motor commutation information, motor velocity information, and motor position information.

Each of the feedback devices described above must be properly wired to insure proper operation of the servomotor. The wiring practices for each device are described below.

HALL EFFECT DEVICES (SEE FIGURE 2)

Three Hall-effect devices are required to provide commutation information for Pacific Scientific three-phase brushless servo motors. The Hall-effect outputs are open collector transistors. These outputs drive a brushless servo amplifiers sensor inputs which have resistor pull-ups.

Wiring for the Hall-effect devices consists of one wire for each of the three sensor signals and two wires which provide power to the Hall-effect devices. The three sensor signal wires should be twisted together and the two power wires should be twisted together as shown in 2a.

For improved noise immunity, the five wires can be placed in a shield which is connected to the 12V RTN at the controller as shown in 2b. This is especially important if the motor wiring is run near (within 12 inches) of the sensor wiring. The shield should only be connected at the controller end.

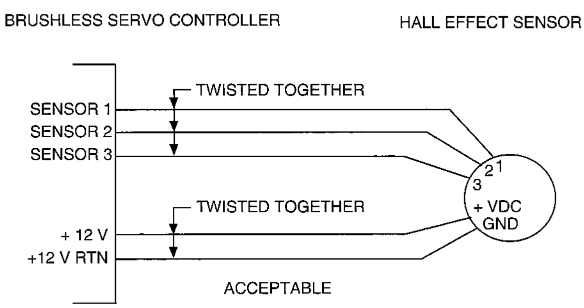

Figure 2a

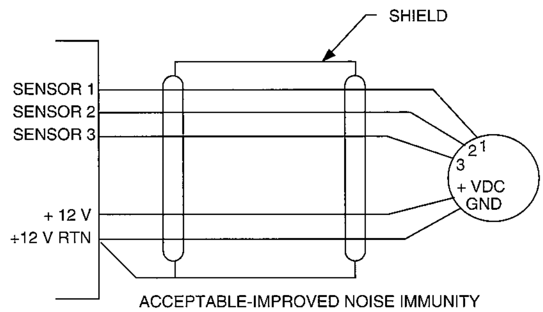

Figure 2b

HALL EFFECT SENSOR WIRING (FIGURE 2)

RESOLVER WIRING (SEE FIGURE 3)

The resolver is a six wire device. Two of the wires are a high frequency excitation signal. The remaining four wires are outputs which supply commutation, velocity, and position information to the amplifier or controller. These four wires are separated into two distinct pairs: sine (S1 and S3) and cosine (S2 and S4). Hence the six wires are segregated into three pairs. Each pair must be run in a separate shield to insure proper motor operation.

The resolver must always be wired as shown in Figure 3b. Any other wiring scheme may result in improper motor operation.

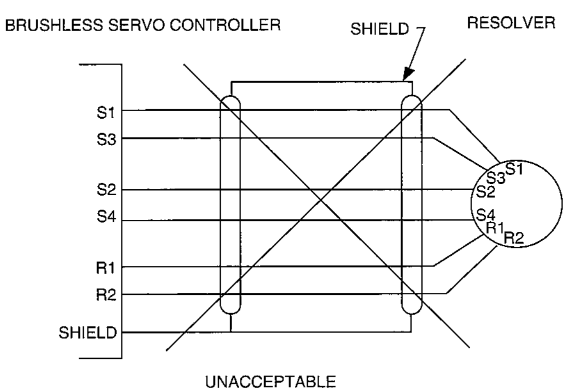

Figure 3a

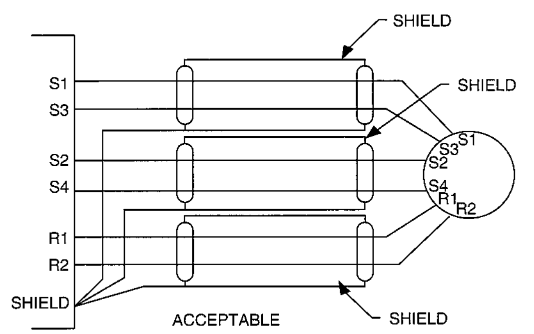

Figure 3b

RESOLVER WIRING (FIGURE 3)

GROUNDING

The grounding procedures listed in the controller instructions should be followed. In general, the following rules should be observed.

All component chassis ground points and signal ground or common points should be tied together at a single point (star connection). This point should then be tied with a single conductor to an earth ground point. This form of grounding prevents ground loops and insures that all components are properly grounded against shock hazard.

SHIELDING

In general, it is good practice to shield all wires carrying low level signals. This is especially important if the signal level wires are run near power level wiring such as motor wires or relay wires.

When shielding wires, connect only one end of the shield, preferably the source end. Connecting both ends of a shield will result in ground loops. It is recommended that the unconnected end of the shield be insulated to prevent accidental connection.

NOTES

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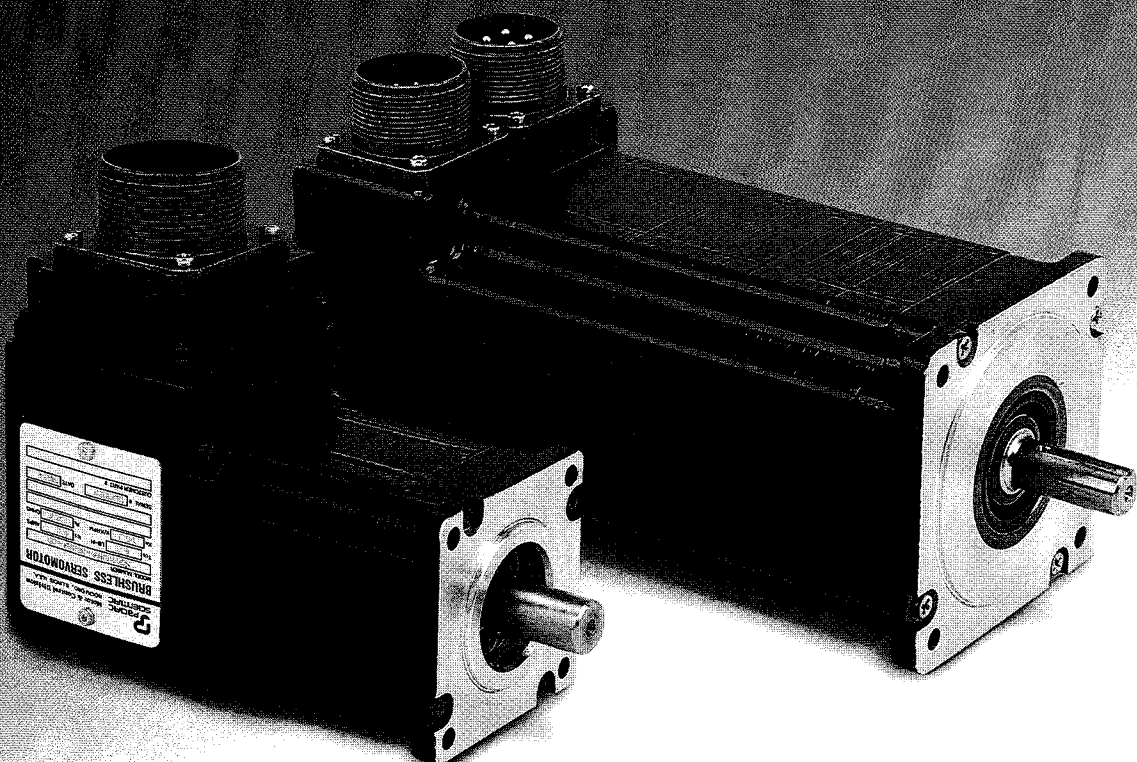

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