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TECHNOLOGY GROUP

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BRUSHLESS SERVO SYSTEMS

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SELECTION OVERVIEW. . .CONTROLLERS

HOW TO USE THIS SECTION

Use the system selection overview (right) as a guide to selecting the level of control you require. Controllers are listed by family/series and functionality.

The table of contents below will help you find the controllers and motors to help you complete your system.

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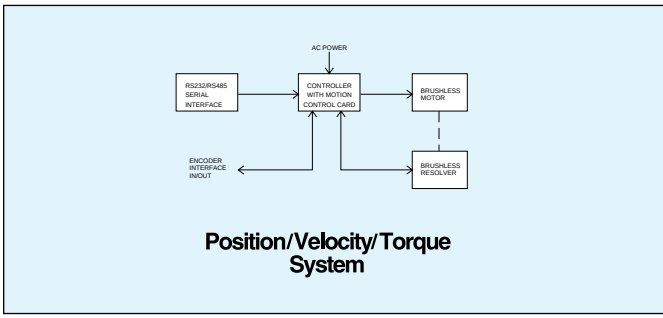
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Accepts an analog or digital command . . .B-6
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Programmable Single Axis
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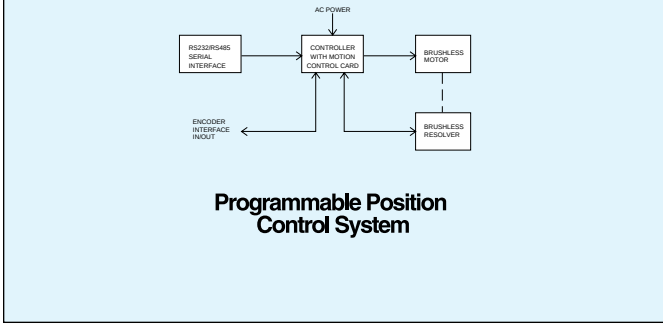
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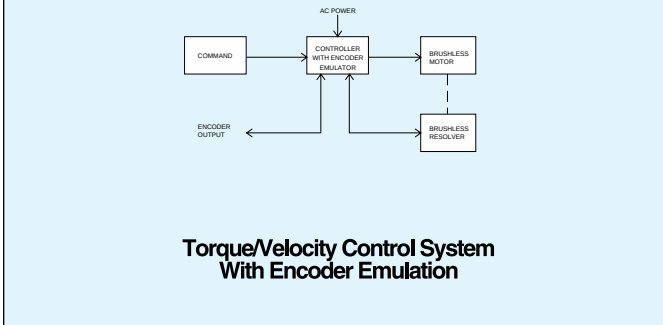
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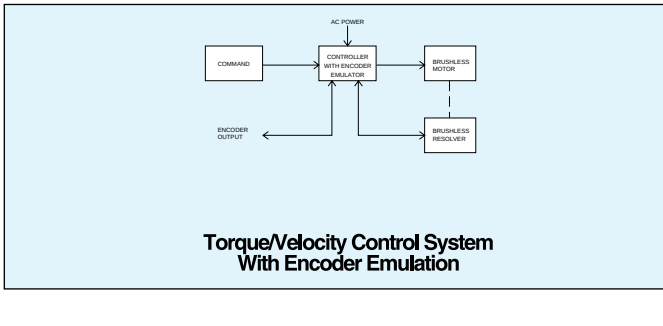
Position/Velocity/Torque System



Programmable Position Control System



Torque/Velocity Control System With Encoder Emulation



Torque/Velocity Control System With Encoder Emulation

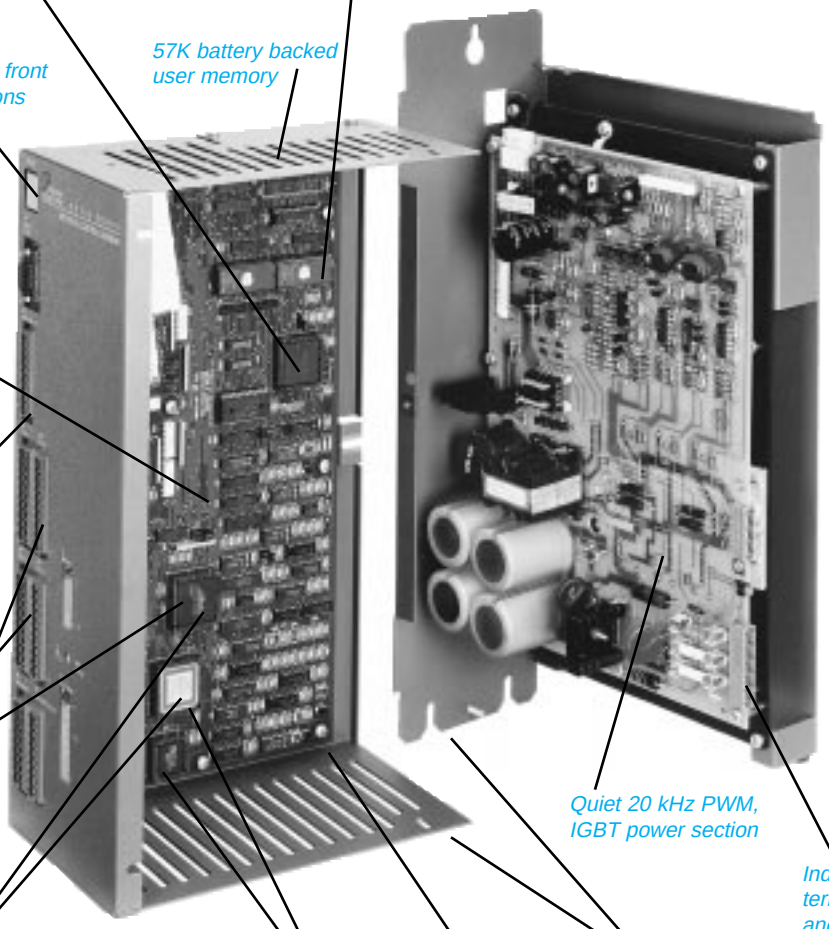
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. . .Brushless Servo Systems

Features	Brushless Servo Controllers		Brushless Servo Motors: R20 Series	R30 Series	R40 Series	F40 Series	R60 Series	R80 Series	Page
			Frame Size (in.): 2	3.25	4.25	4.25	5.75	7.5	
			Max. Continuous Rated Torque (lb-in.) / Speed (rpm)						
• Velocity loop (speed) control • Torque (current) control • Velocity or torque output proportional to ±10V input • Velocity control: user closes position loop • Controller generates encoder outputs from single resolver • Position loop control: user supplies encoder, step/dir signals for command • Digital velocity control: user supplies commands via RS232	SC900 Series	SC902	7.1 / 6000	30 / 1500	33 / 1500	43 / 1000			B-6
		SC903		23 / 3000	61 / 1500	48 / 1500			B-6
		SC904			50 / 3000	43 / 3000	156 / 1000		B-6
		SC905					146 /	424 /	B-6
• Position loop control • Integral programmable position control • Programming in PacSci ServoBASIC *Plus™* • 85K nonvolatile program storage • Programmable I/O • Electronic (master/slave) gearing • Local Area Network. . . PacLAN™	SC750 Series	SC752	7.1 / 6000	30 / 1500	33 / 1500	43 / 1000			B-27
		SC753		23 / 3000	61 / 1500	48 / 1500			B-27
		SC754			50 / 3000	43 / 3000	156 / 1000		B-27
		SC755					146 / 2000	424 / 1000	B-27
		SC756						300 /	B-27
• Velocity loop (speed) control • Torque (current) control • Velocity or torque output proportional to ±10V input • Velocity control: user closes position loop • Torque control: user closes velocity and/or position loop • Controller generates encoder outputs from single resolver	SC720 Series	SC722	7.1 / 6000	30 / 1500	33 / 1500	43 / 1000			B-48
		SC723		23 / 3000	61 / 1500	48 / 1500			B-48
		SC724			50 / 3000	43 / 3000	156 / 1000		B-48
		SC725					146 / 2000	424 / 100	B-48
		SC726						300 /	B-48
• Velocity loop (speed) control • Torque (current) control • Velocity or torque output proportional to ±10V input • Velocity control: user closes position loop • Torque control: user closes velocity and/or position loop	SC400 Series	SC402		30 / 1500	33 / 1500				B-60
		SC403		23 / 3000	61 / 1500				B-60

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DISCOVER THE PACSCI DIFFERENCE



Digital auto-tuning—no potentiometers to tweak!

16 bit microprocessor for 0.6 mS processing speed

57K battery backed user memory

Extensive diagnostics, front access to all connections

SC750 Series full digital position controllers

PacLAN™ high speed (2.5 Mbaud) LAN port

28 user programmable I/O

Better commutation! Digital signature control (patents pending)

ASICs for economical, compact design

Improved position control! Resolver-to-digital conversion (patents pending)

Modular design for interchangeability

Noise immune, totally enclosed steel packaging

Quiet 20 kHz PWM, IGBT power section

Industrial, screw terminal connections and pluggable cables

ServoBASIC Plus™ — enhanced programming language

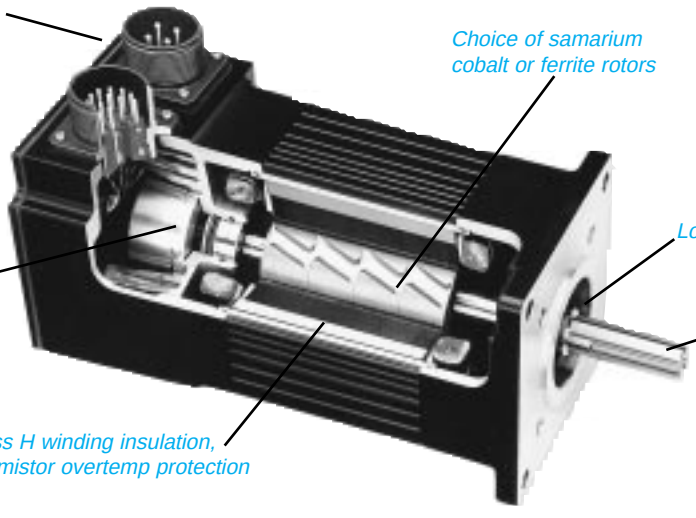
Motion Dialogue™ menu driven development environment

5 power levels — from 4.8 lb-in. cont. to 800 lb-in. peak rated torque

Economical SC720 Series velocity and/or torque controller versions

Single or multi-axis use

***2 year warranty -** motors and controllers*



TENV, NEMA and IP65 construction

Choice of samarium cobalt or ferrite rotors

Long life bearings

Rugged single resolver feedback

English and metric pilot dimensions, NEMA C-face in popular models, shaft options

Class H winding insulation, thermistor overtemp protection

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BRUSHLESS SERVO CONTROLLERS

From full-featured to economical OEM packages, Pacific Scientific has the right brushless servo controller for your performance and cost requirements.

We are pleased to introduce the SC900, our newest family of high-performance brushless servo controllers. The SC930 is the first series of this family to be released. This “state of the art” controller is fully digital and very flexible. It can function as a velocity or torque loop commanded by a standard analog (±10V) signal. Because it is digital, it also has the capability of following a digital velocity command entered through the serial port or following a position command entered in step- and -direction or quadrature encoder format. As an extension of this digital flexibility, these drives have 6 mappable, bi-directional I/Os. These I/O points can be used to simulate real world functionality such as Clutch/Brake, Over Travel Limits, and Soft Start Acceleration.

This family mates to all of Pacific Scientific high performance brushless motors using reliable resolver feedback devices.



The SC700 family incorporates design inputs from over 3,000 industrial motion control users. You’ll find the SC700 simple to apply and maintain, plenty rugged for the factory floor, and flexible to meet your changing needs.

For plug & play system, specify our SC750 Series digital position controllers. Autotuning makes setup a breeze. Programming is easy in the PacSci ServoBASIC *Plus™* environment. And our proprietary digital control techniques mean you don’t have to sacrifice performance for digital convenience.

Our latest generation SC720 Series torque/velocity controllers let you close the loop with your own position controller or PLC servo module. All parameters are readily adjusted through a removable personality module. The SC720 simplifies control by generating quadrature position feedback and communication signals from a single motor-mounted resolver.

The SC400 Series torque/velocity controllers offer economical and space-saving alternatives and are specifically designed for use with popular 3.25” and 4.25” frame motors. With PacSci, you never have to settle for too much—or too little—servo controller.

And remember, PacSci always stands behind its controllers and motors with a 2 year warranty.



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SC900 SERIES

Peak torque range:
10 to 800 in-lb. (1.1 to 90 Nm)

Digital Servo Drive

1.1 kW to 9 kW continuous power
2.2 kW to 18 kW peak power



© SC900 Controllers are UL Recognized (File E137798)

FEATURES

- All digital DSP–based
- Standard analog and digital interfaces
  - ± 10V Analog interface–Velocity or torque control
  - Step/Direction Digital interface–Position or velocity control
  - Step Up/Step Down interface–Position or velocity control
  - Quadrature Encoder Digital interface–Electronic gearing follower
- Removable option card for flexibility
  - RS-232/485 serial interface
  - SERCOS multi-axis fiber optic interface
  - Expanded I/O
  - Field firmware upgrade
- Personality parameters in base drive or on removable option card (EEPROM)
- Digital auto-tuning for easy set-up–no pots to tweak
- All system and application parameters set in software and can be saved in EEPROM
- Single resolver feedback survives hostile environments
- Optionally used incremental encoder and/or commutation
- Quadrature encoder outputs up to 16,384 PPR
- Digital and analog I/O
- Total front access to clearly marked connectors
- Extensive protection circuits and diagnostics to ease set-up
- Inaudible, high frequency, Digital PWM sine wave current control

When combined with Pacific Scientific's brushless servo motors, the SC900 Series drives provide continuous torques ranging from 4.8 lb-in to 451 lb-in and peak torques from 10 lb-in to 800 lb-in. Standard motor power and resolver feedback cables are available to complete your motion control system and provide reliable, trouble-free startup and operation.

APPLICATIONS

- Packaging Machinery
- Electronic Assembly Equipment
- Material Handling
- Robotics
- X-Y Tables and Slides
- Specialty Machinery
- Multi-axis Systems

PRODUCT DESCRIPTION

The Pacific Scientific SC900 Series is a family of next generation digital, servo drives. These drives utilize a single DSP to close the current, velocity, and position loops. All system and application parameters are set in software to insure repeatability and to eliminate drift. The SC900 Series is available in four power levels, all with integral power supplies and shunt regulators.

The base SC900 unit includes several command interface features. A standard ± 10V analog interface is available to command motor torque or velocity. Two standard stepper interfaces, step/direction and Step Up/Step Down, are also available to command motor position or velocity. The drive can also be used in an electronic gearing follower mode by using the quadrature encoder input.

Various option cards are available to increase the functionality of the base SC900 drive. The option card is required to set the base SC900 parameters, but can be removed once set up is complete. All option cards have the capability to replace the base drive's personality parameter non-volatile storage and provide removable personality parameter storage. The option cards also allow SC900 firmware upgrades, which eliminates the need to disassemble equipment or the drive when upgrading.

RS-232/485 Serial Interface OC930 Option Card

This card allows the user to program the various SC900 set-up parameters using an IBM-compatible PC. It also allows the SC900 to be connected to any host computer containing RS-232/485 communications capability.

SERCOS Interface OC940 Option Card

This card adds SERCOS (**SE**rial **R**eal-time **CO**mmunications **S**ystem) fiber optic communication capability to the SC900. See pages B-21–B-26 for more details.

Programmable Single Axis Position Control OC950 Option Card

This card allows the user to program the option card to increase functionality of the base SC900 drive. See pages B-19 & B-20 for more details.

DIGITAL RESOLVER-TO-DIGITAL CONVERSION

A patented Digital Resolver-to-Digital Converter called DRDC provides industry leading 24-bit-per-revolution position resolution. This very high position resolution yields an all digital velocity control with smoothness indistinguishable from an all analog control. U.S. Patent 5,162,798.

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SIGNATURE CURRENT CONTROL

The SC900 Series utilizes signature control, a proprietary form of brushless motor sinusoidal commutation. This current control technique significantly reduces ripple torques due to harmonics in the motor's back EMF wave form. By tailoring the sinusoidal current's wave shape or "signature" to match the motor's back EMF, electro-magnetic ripple torque is reduced to ±2% or less. In your application, this results in excellent machine precision and smoothness with high throughput capability. This proprietary commutation contol also provides exceptional high-speed motor control.

FULL DIGITAL CONTROL

The combination of DSP, DRDC, and ASICs (Application Specific Integrated Circuits) give the SC900 its all digital advantage. An all digital implementation reduces component count to increase reliability while reducing cost, eliminates analog drift, eliminates imprecise potentiometer adjustments, reduces size, and increases flexibility.

AUTOTUNING

In many applications, the Autotuning feature will automatically set the servo system compensation parameters. You won't need oscilloscopes, meters, or other instruments–just a personal computer–to set up your system. The system allows you to select the type of performance desired.

IGBT PWM POWER STAGE

Insulated Gate Bipolar Transistor (IGBT) technology is used in the power stage of every SC900 Series drive. This technology makes exceptionally efficient use of PWM frequencies above the audible range. As a direct result, motor operation is more efficient and the annoyance of audible PWM noise is eliminated.

I/O

- Differential ±10V analog input
- 2 ±5V Analog outputs
- 6 Bi-directional input/outputs, TTL or 24V logic compatible
- Encoder quadrature output
- Encoder quadrature input (Step/Direction, Step Up/Step Down)
- Enable input
- +5Vdc @ 200 mA user output

COMMUNICATIONS

- OC930 Serial Option Card
  - RS-232 9600 Baud
  - RS-485 9600 Baud, 32 node
- OC940 SERCOS Option Card

OPERATING FEATURES

- Smooth, digital, high bandwidth position/velocity/torque control
- Transformerless, direct 120/240 Vac line operation
- IGBT PWM output stage
- Fully enclosed, panel mount package

ADJUSTMENTS

- All adjustments made in software

PROTECTION/DIAGNOSTICS

- 7 segment status display
- In-rush current limiting
- Control Power Fuse
- Output short circuit protection
- Overtemperature protection, motor and drive
- IT protection
- Under voltage protection
- Excessive regeneration protection

AGENCY APPROVAL

- UL recognized – 508C (Type R) – file #E137798
- Meets CSA Standard, C22.2 #142-M1987
- Meets IEC Vibration Standard, #68-2-6

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DIMENSIONS in. (metric dimensions for ref. only)

SC902, 903 and 904

DIMENSIONS LEGEND				
MODEL	PEAK	A	B	C
SC9X2	7.5A	2.25" [57.2mm]	1.12" [28.6mm]	N/A
SC9X3	15A	3.25" [82.67mm]	1.75" [44.45mm]	N/A
SC9X4	30A	3.20" [81.4mm]	1.60" [40.6mm]	4.52" [114.8mm]

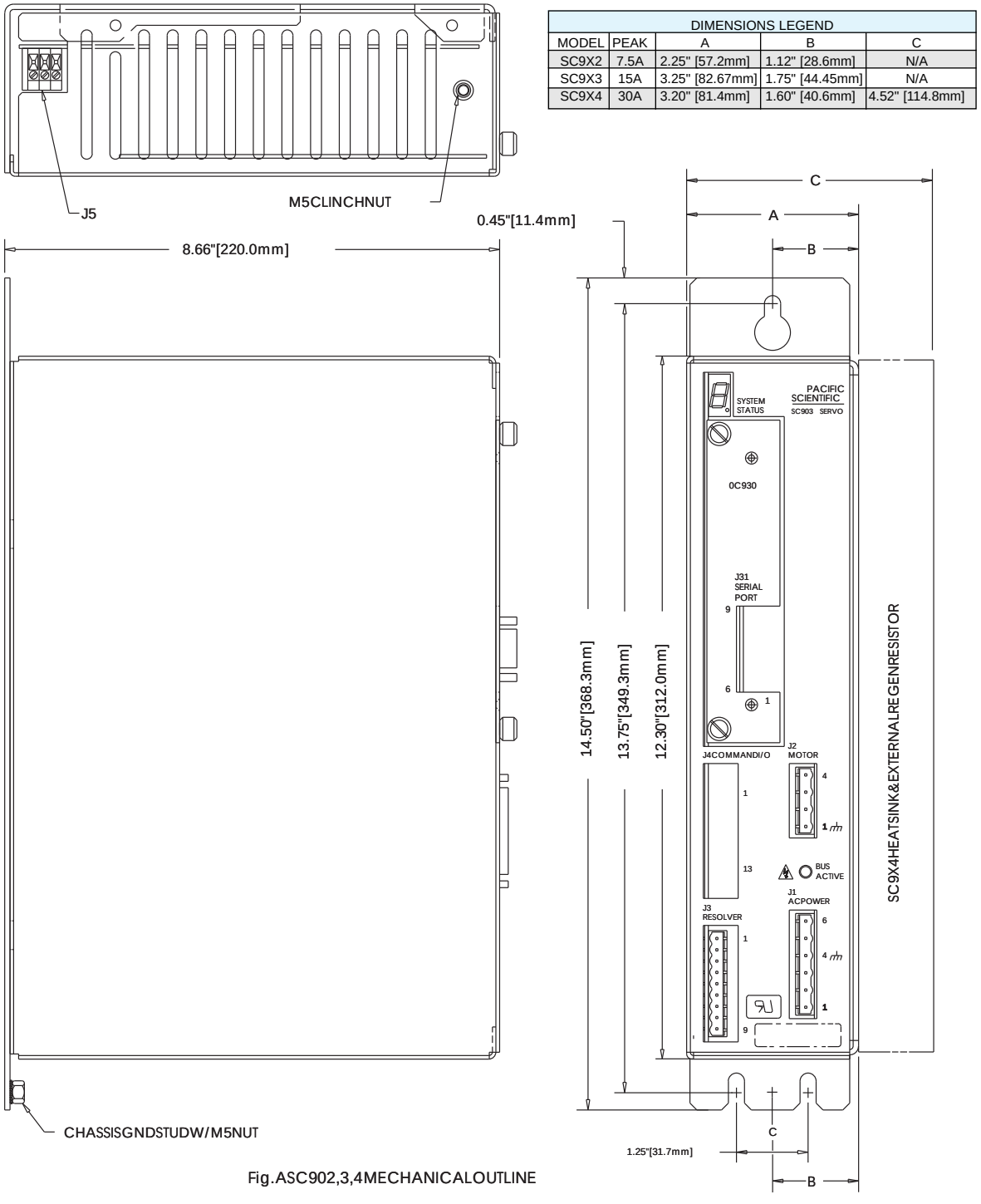
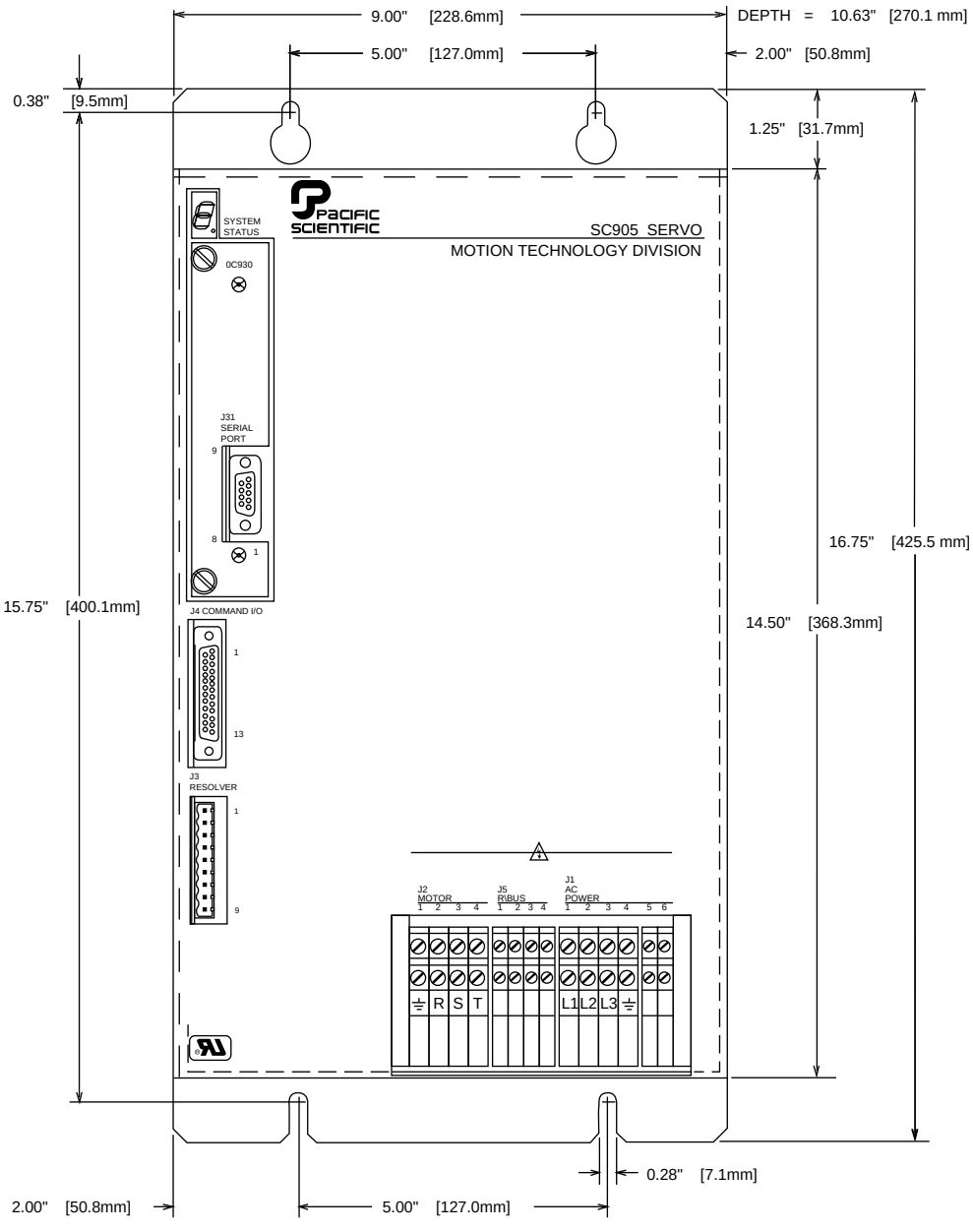


Fig.ASC902,3,4MECHANICALOUTLINE

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DIMENSIONS in. (metric dimensions for ref. only)

SC905

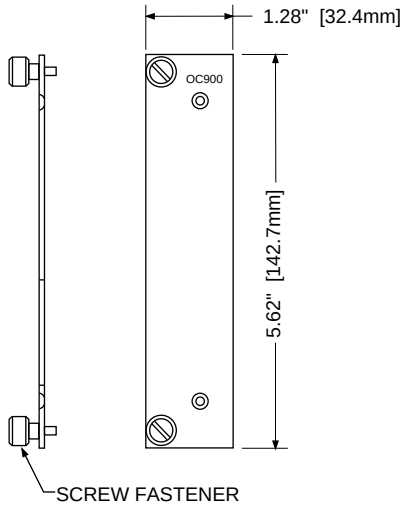


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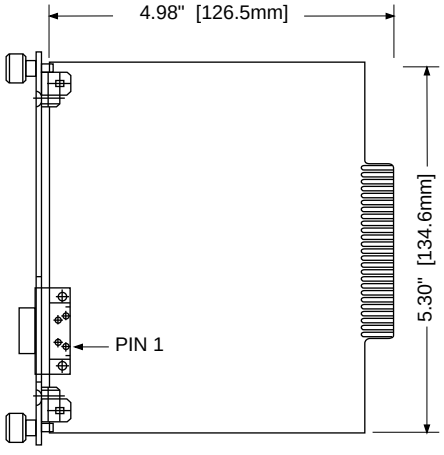
DIMENSIONS in. (metric dimensions for ref. only)

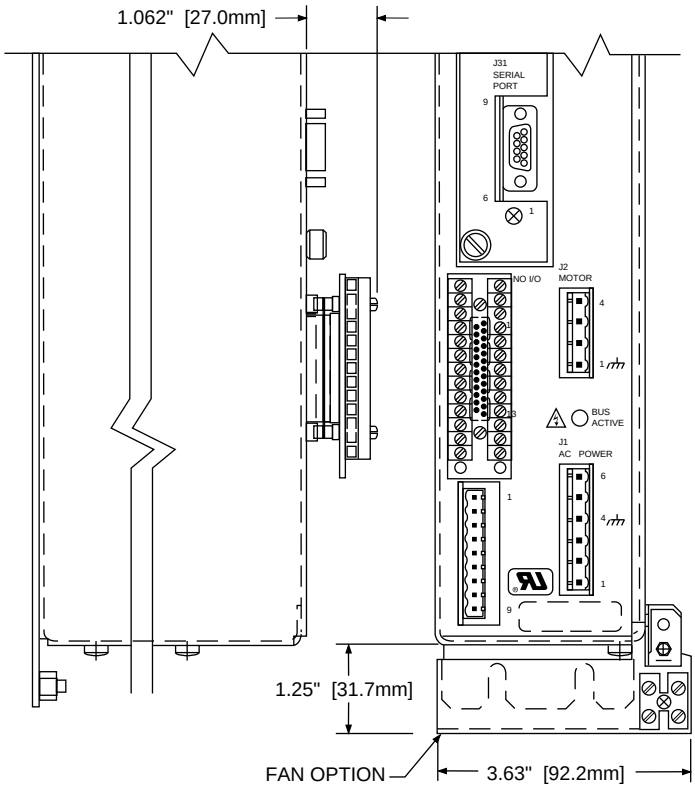
SC900 SERIES OPTIONS

OC900 BLANK PANEL

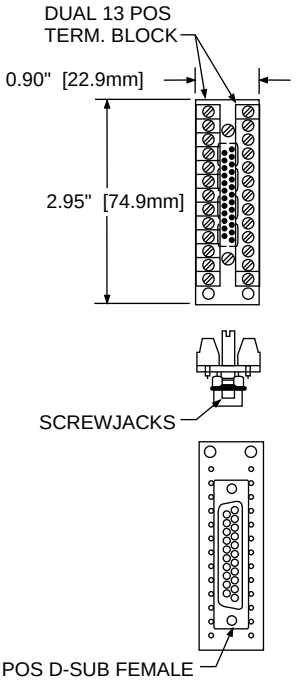


0C930 OPTION CARD





TERMINAL BLOCK ADAPTER



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GENERAL...SC900 Digital Drives

Analog Input Command	
Range	±13.5V velocity or torque
Resolution	≥14 bits
Offset	Adjustable to zero
Offset drift	100 µV/°C typical
Digital Input Command	
Modes	Step/Direction, Step Up/Step Down, Quadrature Encoder
Maximum input frequency	
Step/Direction, Pulse Forward/Reverse	1 MHz
Quadrature Encoder	833 kHz
Current Loop	
Bandwidth	1500 Hz maximum
Update period	62.5 ∝S
Velocity Loop	
Bandwidth	400 Hz maximum
Update period	250 ∝S
Command resolution	<0.001 rpm
Feedback accuracy	0.05% worst case
Feedback ripple	0.75% p-p at 1000 rpm (drive only) 3% p-p at 1000 rpm (with 20 arcmin resolver)
Feedback Resolution	0.014 rpm
Range	0 to 30,000 rpm
Position Loop	
Bandwidth	100 Hz maximum
Update period	1 mS
Command resolution	65,536 steps/rev (16 bits/rev)
Feedback accuracy	±5.3 arcmin (drive only) ±25 arcmin (with 20 arcmin resolver)
Feedback Resolution	16,777,216 (24 Bits/Rev)
Encoder Output Signals	
Type	Quadrature with marker pulse, differential TTL line driver
Resolution	128 to 16384 PPR by powers of 2 125 to 16,000 PPR by powers of 2
Maximum output frequency	833 kHz
Marker pulse width	1 quadrature pulse nominal
Serial Port (Serial Comm Option Card)	
Type	RS-232, RS-485
Baud rate	9600 baud
Maximum RS-485 nodes	32
Dedicated I/O	Enable 5V or 24V compatible
Programmable I/O	6 bi-directional 5V or 24V compatible, 2 analog outputs
Mating connectors	Power-screw terminal Signal-screw terminal or D-connectors

ENVIRONMENTAL . . . SC900 Digital Drives

Storage temperature	- 40°C to 70°C
Operating temperature	
Full ratings	0°C to 50°C
Derated convection [1]	25°C to 60°C
Derated forced air [2]	50°C to 60°C
Altitude	1500m (5000 ft.)
Humidity	10% to 90%, non-condensing

[1] Linearly derate output power and output current from full rating at 25°C to 53% at 60°C.
[2] Linearly derate output power and output current from full rating at 50°C to 66% at 60°C.

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POWER DATA. . .SC900 Digital Drives

	SC9x2	SC9x3	SC9x4	SC9x5
Input Voltage	90 to 264 Vac, 50/60 Hz, 1 phase			
Control logic power	120/240 Vac (+ 10%, -15%) 50/60 Hz, 1 or 3 phase		240 Vac (+10%,-15%), 50/60 Hz, 3 phase	
Bus power (with 240 Vac, 3 phase)				
Input Current	500 mA max. @ 120 Vac, 250 mA max. @ 240 Vac.			
Control logic power				
Bus power	4.5 A_{rms}	9 A_{rms}	18 A_{rms}	29 A_{rms} (@6kW)
Peak Output Current (0-p) [2]				
5 Seconds, up to full 50°C	7.5 A	15 A	30 A	60 A
Continuous Output current (0-p) [2]				
25°C Convection cooling	3.75 A	7.5 A	15 A	30 A
50°C Forced air cooling	3.75 A	7.5 A	15 A	30 A
50°C Convection cooling	2.5 A	5.0 A	10 A	30 A
Peak Output Power @ 240 Vac [1]				
1 second, up to full 50°C	2.2 kW	4.5 kW	9 kW	18 kW
Continuous Output Power				
@240 Vac three phase				
25°C Convection cooling	1.1 kW	2.2 kW	4.5 kW	9 kW
50°C Forced air cooling	1.1 kW	2.2 kW	4.5 kW	9 kW
50°C Convection cooling	0.75 kW	1.5 kW	3.0 kW	9 kW
@240 Vac single phase [1]				
25°C Convection cooling	0.80 kW	1.6 kW	2.3 kW	N/A
50°C Forced air cooling	0.80 kW	1.6 kW	2.3 kW	N/A
50°C Convection cooling	0.55 kW	1.1 kW	1.5 kW	N/A
Power Stage Efficiency @ P_{cont}	>95%	>96%	>97%	>97%
Shunt Regulator Power				
Peak power (300 mSec)	3.0 kW	6.0 kW	12 kW	20 kW
Continuous power				
25°C Convection cooling	20 W	40 W	100 W	200 W
50°C Forced air cooling	25 W	50 W	125 W	200 W
50°C Convection cooling	20 W	40 W	100 W	200 W
Maximum external regen duty cycle	16%	12%	6%	10%
Bus capacitance energy absorption from 320V nominal bus	15 Joules	15 Joules	30 Joules	50 Joules
Output Current Ripple Frequency f_S	20 kHz	20 kHz	20 kHz	20 kHz
Minimum Motor Inductance l-l	2.6 mH	1.3 mH	.7 mH	0.3 mH
Maximum Motor Power Cable Length	50 m/164ft	50 m/164ft	50m/164ft	50m/164ft

[1] For standard 120 Vac single phase operation, derate the Peak and Continuous Output Power ratings by 40%. Consult factory for 120 Vac bus voltage doubled customization specifications. Although possible, single phase operation of the SC9x4 and SC9x5 is not recommended.

[2] Currents are the Zero-To-Peak of a Sinewave. Multiply by 0.707 to get RMS current values.

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Parameter (Partial List)	Description
Current Loop	
KIP	Current loop proportional gain (V/A)
ILMTPLUS	Plus current limit (%)
ILMTMINUS	Minus current limit (%)
COMMOFF	Commutation offset angle (Deg)
COMMSRC	Selects commutation feedback device
POLECOUNT	Motor pole count
ITTHRESH	Threshold for drive IT protection (%)
VBUSTHRESH	Threshold for low motor bus fault (V)
Velocity Loop	
KVP	Velocity loop proportional gain (A/rad/sec)
KVI	Velocity loop integral gain (Hz)
AFR0, ARF1	Anti-resonance filter break frequencies (Hz)
ARZ0, ARZ1	Anti-resonance zero frequencies (Hz)
Position Loop	
KPP	Positon loop proportional gain (Hz)
KVFF	Velocity feed forward gain (%)
Block Type	
BLKTYPE = 0	Analog command torque block
BLKTYPE = 1	Analog command velocity block
BLKTYPE = 2	Incremental command position block
BLKTYPE = 4	Digital frequency command torque block
BLKTYPE = 5	Digital frequency command velocity block
With OC930	
BLKTYPE = 2	Serial port command position block
BLKTYPE = 8	Serial port command velocity block
Feedback Source	
REMOTEFB = 0	Use motor shaft resolver for position feedback
REMOTEFB = 1	Use encoder input for position feedback
REMOTEFB = 2	Use encoder input for position and velocity feedback
Encoder Output	
ENCOUT	Encoder output resolution (PPR)
Encoder Input	
ENCIN	Encoder input resolution (PPR)
ENCMODE	Encoder input mode, quadrature/step, dir/Up, Dn
Digital I/O	
BDIOMap1-6	Selects input or output function for each BDIO
Analog Out	
DMxMAP	Selects signal for channel x
DMxGain	Set output volt per signal unit
DMxF0	Low pass filter in H_z for channel x

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SC900 SERIES RECOMMENDED MOTOR/DRIVE SYSTEMS [1]

In addition to the motors shown, a series of explosion-proof brushless servo motors are available. These motors are UL Listed (File 150845). Contact your PacSci distributor or Pacific Scientific direct for detailed technical information.

Peak stall torque T_{PS} [1] lb-in./Nm	Peak rated torque T_{PR} [2] lb-in./Nm	Cont. stall torque T_{CS} lb-in./Nm	Cont. rated torque T_{CR} lb-in./Nm	Rated Speed W_R [3] rpm	Inertia x 10^{-3} [4] lb-in-S^2/ kgm^2 J	Servo-motor Dia. or Width/height inch/mm	Servo-motor Length inch/mm	Inductance line-line L mH	Servo motor model	Servo-drive model [5]
With R Series (low inertia, high performance) motors										
10/ 1.1	6.5/ .7	4.8/ .5	2.5/ .3	8000	0.12/ .014	2.00/ 50.8	7.38/187.5	5.3	R22HENA-R1-NS-NV-01	SC932AN-001-01
14/ 1.6	8/ .9	7.6/ .9	5.2/ .6	8000	0.15/ .017	2.00/ 50.8	8.38/212.9	6.5	R23HENA-R1-NS-NV-01	SC932AN-001-01
17/ 1.9	10/ 1.1	9.2/ 1.0	7.1/ .8	6000	0.18/ .020	2.00/ 50.8	9.38/238.3	6.5	R24HENA-R1-NS-NV-01	SC932AN-001-01
27/ 3.0	25/ 2.8	14/ 1.6	10/ 1.1	4000	0.55/ .062	3.25/ 82.6	7.09/180.1	23.0	R32GENC-R2-NS-NV-00	SC932AN-001-01
27/ 3.0	25/ 2.8	14/ 1.6	6/ .7	7000	0.55/ .062	3.25/ 82.6	7.09/180.1	5.8	R32HENC-R2-NS-NV-00	SC933AN-001-01
36/ 4.0	33/ 3.7	21/ 2.4	16/ 1.8	3000	0.74/ .084	3.25/ 82.6	8.09/205.5	22.0	R33GENC-R2-NS-NV-00	SC932AN-001-01
36/ 4.0	25/ 2.8	21/ 2.4	10/ 1.1	6000	0.74/ .084	3.25/ 82.6	8.09/205.5	5.6	R33HENC-R2-NS-NV-00	SC933AN-001-01
45/ 5.0	42/ 4.7	27/ 3.0	24/ 2.7	2800	0.92/ .104	3.25/ 82.6	9.09/230.9	30.0	R34JENC-R2-NS-NV-00	SC932AN-001-01
45/ 5.0	38/ 4.3	27/ 3.0	16/ 1.8	4000	0.92/ .104	3.25/ 82.6	9.09/230.9	7.5	R34KENC-R2-NS-NV-00	SC933AN-001-01
54/ 6.0	53/ 5.9	32/ 3.6	30/ 3.4	2000	1.11/ .125	3.25/ 82.6	10.09/256.3	42.0	R35JENC-R2-NS-NV-00	SC932AN-001-01
54/ 6.0	48/ 5.4	32/ 3.6	23/ 2.6	3000	1.11/ .125	3.25/ 82.6	10.09/256.3	10.5	R35KENC-R2-NS-NV-00	SC933AN-001-01
66/ 7.4	50/ 5.6	33/ 3.7	33/ 3.4	1800	1.90/ .215	4.25/108.0	8.34/211.8	53.0	R43GENA-R2-NS-NV-00	SC932AN-001-01
66/ 7.4	60/ 6.7	33/ 3.7	31/ 3.5	3000	1.90/ .215	4.25/108.0	8.34/211.8	13.3	R43HENA-R2-NS-NV-00	SC933AN-001-01
106/11.9	95/10.6	48/ 5.4	46/ 5.2	2000	2.70/ .305	4.25/108.0	9.84/249.9	4.9	R45GENA-R2-NS-NV-00	SC933AN-001-01
106/11.9	95/10.6	48/ 5.4	43/ 4.8	4000	2.70/ .305	4.25/108.0	9.84/249.9	20.0	R45HENA-R2-NS-NV-00	SC934AN-001-01
142/15.9	120/13.4	64/ 7.2	61/ 6.8	1500	3.50/ .395	4.25/108.0	11.34/288.1	25.0	R46GENA-R2-NS-NV-00	SC933AN-001-01
142/15.9	120/13.4	64/ 7.2	50/ 5.6	3000	3.50/ .395	4.25/108.0	11.34/288.1	6.2	R46HENA-R2-NS-NV-00	SC934AN-001-01
150/16.8	125/14.0	70/ 7.8	58/ 6.5	3000	7.10/ .818	5.75/146.1	9.36/237.7	8.9	R63GENA-R2-NS-NV-00	SC934AN-001-01
150/16.8	142/15.9	70/ 7.8	38/ 4.3	6000	7.10/ .818	5.75/146.1	9.36/237.7	2.2	R63HENA-R2-NS-NV-00	SC935AN-001-01
240/26.9	230/25.8	115/12.9	102/11.4	1700	11.10/1.28	5.75/146.1	11.36/288.5	13.7	R65GENA-R2-NS-NV-00	SC934AN-001-01
240/26.9	200/22.4	115/12.9	90/10.1	3000	11.10/1.28	5.75/146.1	11.36/288.5	3.4	R65HENA-R2-NS-NV-00	SC935AN-001-01
340/38.1	305/34.2	168/18.8	156/17.5	1000	15.10/1.74	5.75/146.1	13.36/339.3	18.2	R67GENA-R2-NS-NV-00	SC934AN-001-01
340/38.1	330/37.0	168/18.8	146/16.4	2000	15.10/1.74	5.75/146.1	13.36/339.3	4.6	R67HENA-R2-NS-NV-00	SC935AN-001-01
300/33.6	280/31.4	190/21.3	125/14.0	3800	39.10/4.50	7.50/190.5	10.93/277.6	3.2	R84GENA-R2-NS-NV-00	SC935AN-001-01
410/45.9	395/44.2	276/30.1	225/25.2	2000	58.10/6.69	7.50/190.5	12.93/328.4	3.6	R86GENA-R2-NS-NV-00	SC935AN-001-01
540/60.5	525/58.8	357/28.8	325/36.4	1500	76.10/8.77	7.50/190.5	14.93/379.2	4.0	R88GENA-R2-NS-NV-00	SC935AN-001-01
800/89.6	730/81.8	451/50.5	424/47.5	1200	95.10/10.96	7.50/190.5	16.93/430.0	7.4	R8AGENA-R2-NS-NV-00	SC935AN-001-01
With F Series (medium inertia for load matching) motors [6]										
60/ 6.8	50/ 5.6	33/ 3.7	32/ 3.6	1500	9.20/1.04	4.25/108.0	8.34/211.8	49.0	F43GENA-R2-NS-NV-00	SC932AN-001-01
60/ 6.8	50/ 5.6	33/ 3.7	31/ 3.5	3000	9.20/1.04	4.25/108.0	8.34/211.8	12.0	F43HENA-R2-NS-NV-00	SC933AN-001-01
80/ 9.0	65/ 7.3	48/ 5.4	48/ 5.4	1000	13.70/1.55	4.25/108.0	9.84/249.9	69.0	F45FENA-R2-NS-NV-00	SC932AN-001-01
80/ 9.0	65/ 7.3	48/ 5.4	47/ 5.3	2000	13.70/1.55	4.25/108.0	9.84/249.9	17.0	F45GENA-R2-NS-NV-00	SC933AN-001-01
115/13.0	88/ 9.9	63/ 7.1	61/ 6.9	1500	17.70/2.00	4.25/108.0	11.34/288.1	24.0	F46GENA-R2-NS-NV-00	SC933AN-001-01
115/13.0	88/ 9.9	63/ 7.1	56/ 6.3	3000	17.70/2.00	4.25/108.0	11.34/288.1	6.0	F46HENA-R2-NS-NV-00	SC934AN-001-01

[1] See page A-56 for definitions of ratings.

[2] Peak torque ratings are for 5 seconds.

[3] Rated speed is provided for operation on 240 Vac 3-phase line. Reduce to approximately 85% for 240 Vac 1-phase line operation and to 40% for 120 Vac 1-phase line operation.

[4] Includes primary feedback inertia.

[5] Model numbers shown include full accessory kit and OC930-001 serial communications card. These models *do not include* the 240 Vac fan option. See "How to Order" on page B-18 for more information.

[6] Each system requires one feedback and one motor power cable.

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CONNECTION DIAGRAM . . .SC900 Series Digital Drives

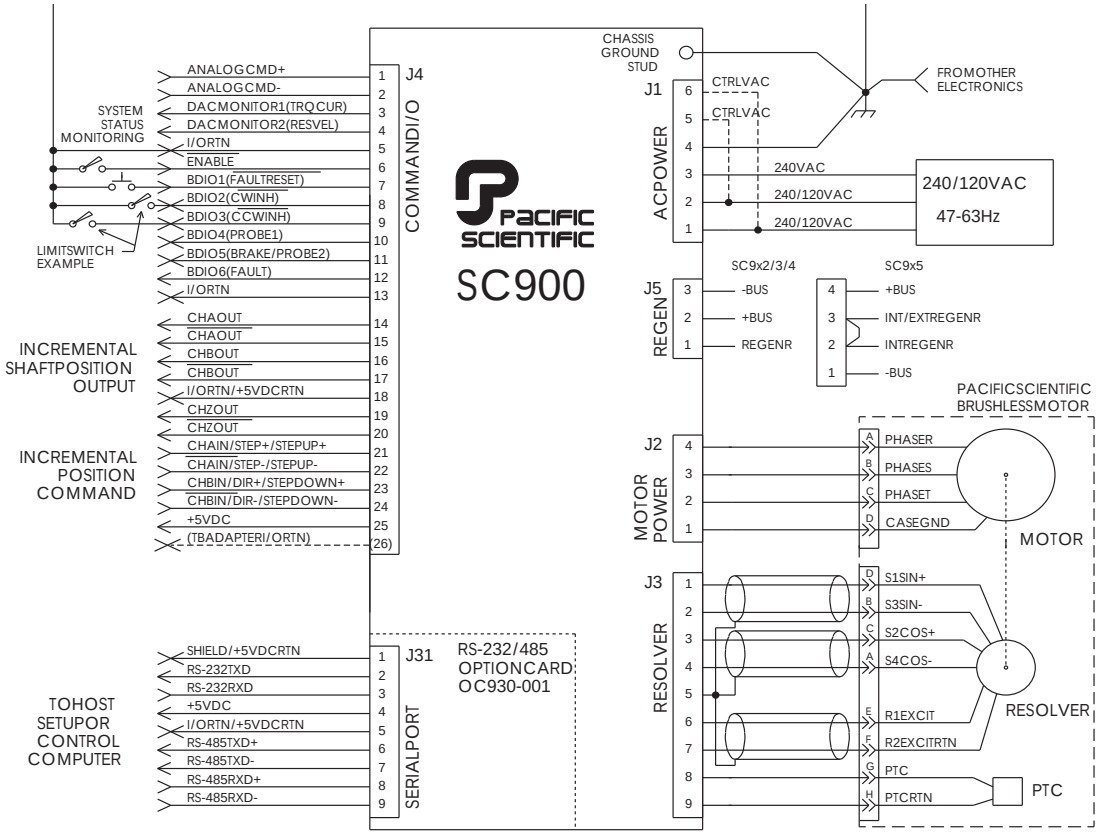


Table 2: Status LED Code List

0	No faults, power stage disabled, bus voltage OK.
8	No faults, power stage enabled, bus voltage OK.
8 < Alternating	No faults, power stage enabled, CcInh active preventing CCW motion
8 > Alternating	No faults, power stage enabled, CwInh active preventing CW motion
8 n Alternating	No faults, power stage enabled, CwInh and CcwInh both active preventing motion.
1 Blinking	Velocity feedback (VeIFB) over speed
2 Blinking	Motor over temperature
3 Blinking	Drive over temperature
4 Blinking	Drive I*t
5 Blinking	SC9x3: Line-neutral over current
6 Blinking	Control ±12V under voltage
7 Blinking	Output over current or Bus over voltage
9 Blinking	Shunt regulator overload
A Blinking	Bus over voltage detected by DSP
b Blinking	Auxiliary +5V low
C Blinking	Not assigned
D Blinking	Not assigned
*E	Processor throughput fault
*E Blinking	Control power ac line dip or power up self test failure
E 1 Blinking	Bus under voltage, bus voltage < VBUSTHRESH*
E 2 Blinking	Ambient temperature too low
E 3 Blinking	Encoder commutation alignment failed (Only for CommSrc = 1)
E 4 Blinking	Software and non-volatile memory versions not compatible
*E 5Blinking	Control card hardware not compatible with software version
E 6 Blinking	Drive transitioned from unconfigured to configured while enabled
F 1 Blinking	Position following error fault
F 3 Blinking	Parameter memory error
U C Blinking	Unconfigured drive

* These fault states can not be reset with the Fault Reset function and require the line control power to be cycled.

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±10 V analog interface--velocity or torque control

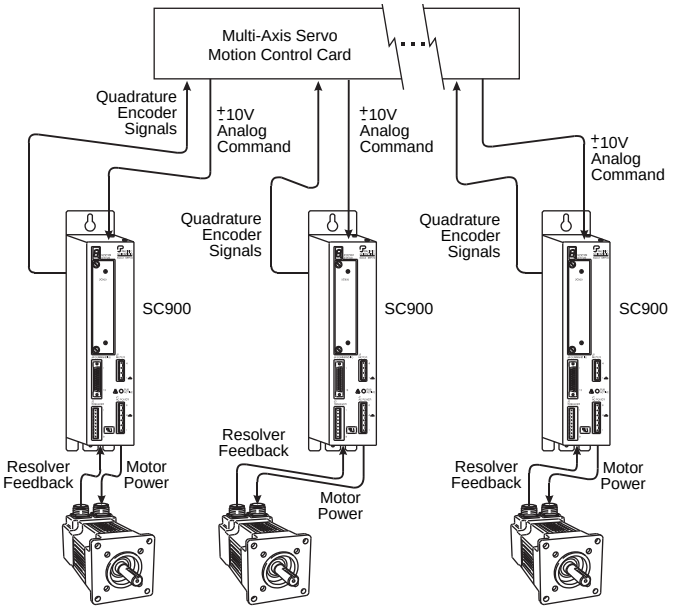


Figure B-1

This multi-axis application utilizes a typical multi-axis motion control card. The motion control card generates ±10 V analog commands for each axis drive. These analog commands control either motor torque or motor velocity. If the control card is commanding torque, the systems velocity loop is closed in the motion control card. If the control card is commanding velocity, the drive closes the velocity loop in the system. The SC900 drive generates quadrature encoder feedback signals from the motor's resolver. These quadrature encoder signals are used by the motion control card to close the system's position loop and to execute the motion profiles.

step/direction digital interface--velocity or position control

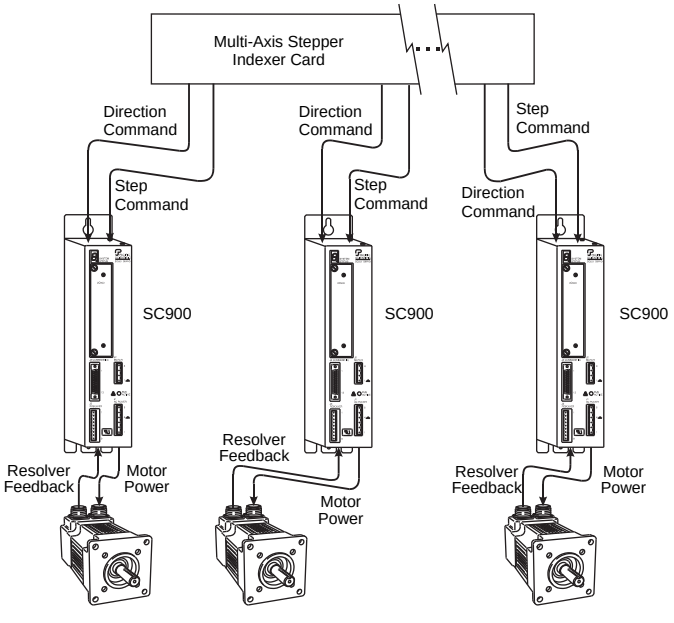


Figure B-2

This multi-axis application utilizes a typical multi-axis stepper indexer card. The indexer generates step and direction commands for each axis drive. These commands control the velocity and position of the servo systems. The drive closes the current, velocity and position loops. Position commands are received via the step and direction interface.

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host computer digital interface— velocity, torque or position control

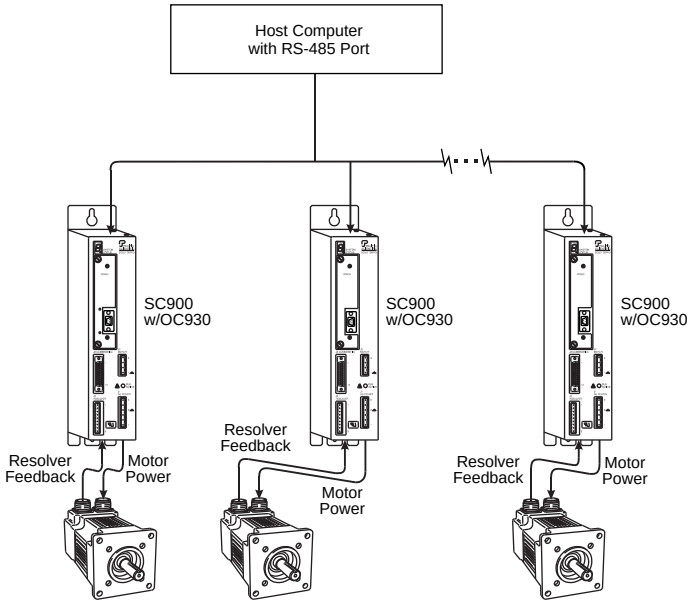


Figure B-3

This multi-axis application utilizes a computer equipped with a serial port. The computer generates velocity, torque or position commands. In that the 9600 Baud serial communications is not very fast, this configuration is best suited for slowly changing or “set and forget” types of applications. It is economical and easy to install. For fast changing applications, refer to Figures B-1 and B-2 (page B-16) and B-4 below.

SERCOS distributed multi-axis control— velocity, torque or position control (available soon)

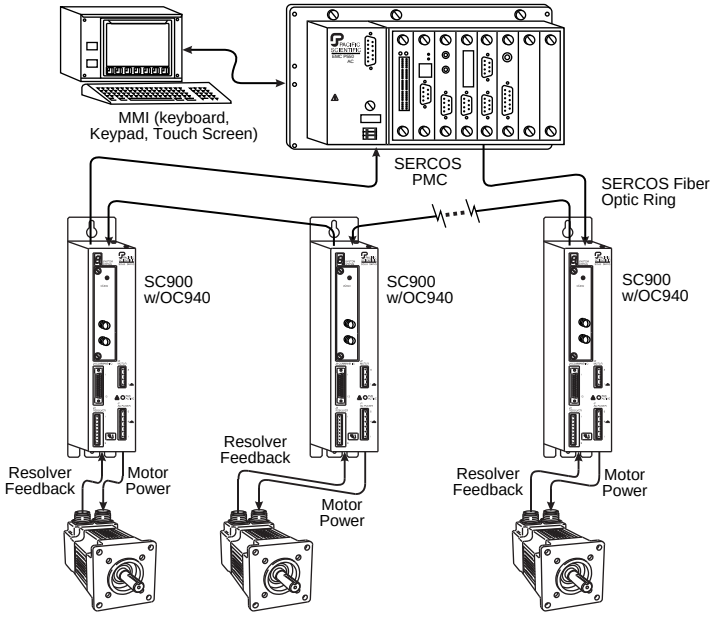


Figure B-4

This multi-axis application utilizes a SERCOS control and SERCOS compatible drives (slaves). SERCOS (**SE**rial **R**ealtime **CO**mmunications **S**ystem) provides a **distributed** multi-axis control topology and is a digital interface international standard. The traditional multi-axis control topology is centralized as shown in Figure B-1 (page B-16). The distributed SERCOS topology is analogous to a network of PCs while the traditional centralized approach is analogous to a mainframe with dumb terminals.

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HOW TO ORDER . . . SC900 Digital Drive . . . Base Drive

MODEL NUMBER CODE

SC9 0 3 N N - 001 - 01

Servo Drive Family Designation

Option Card Designator
- **0** = No option card installed
- **3** = OC930-001-00 Serial Port Option Card installed
- **4** = OC940-001-01 SERCOS Interface Option Card installed
- **5** = OC950-50X-01 Programmable Option Card installed
  (X – See Customization Code below)

Power Level
- **2** = 7.5 A peak, 3.75 A continuous @ 25°C
- **3** = 15 A peak, 7.5 A continuous @ 25°C
- **4** = 30 A peak, 15 A continuous @ 25°C
- **5** = 60 A peak, 30 A continuous @ 50°C

Accessories Option
- **N** = No accessory kit
- **A** = Basic connector kit, manual(s)
- **T** = Terminal block adapter connector kit, manual(s)

Fan Kit Option
- **N** = No fan, convection cooled
- **2** = 240 Vac Fan, forced air cooled
- **1** = 120 Vac Fan, forced air cooled

Customization Code, Factory assigned)
- **001** = Standard Unit

NOTE: The following customization codes are only valid when ordering an SC950.
- **501** = OC950 32Kx8 NV RAM, without PacLAN
- **502** = OC950 128Kx8 NV RAM, without PaacLAN
- **503** = OC950 32Kx8 NV RAM, with PacLAN
- **504** = OC950 128Kx8 NV RAM, with PacLAN

Firmware
- **01** = Standard base servo software

NOTE: Base Servo drive includes Information Sheet. Manual and accessories ordered separately or included by using the **Accessories Option** designator.

HOW TO ORDER . . . SC900 Digital Drive . . . Drive Accessories

Accessory	Description	Order Number
Option Cards:		
Blank panel	This is a blank panel to cover an unused option card slot.	OC900-001
Firmware upgrade	This option card allows easy plug-in upgrading of the SC900 firmware and allows removable personality.	OC900-002-01
Serial communications	This option card adds RS-232/485 serial communications to the base SC900. Suffix -00 is standard, -01 includes base unit firmware upgrade. Includes 3-1/2" floppy disk with PC communications utility.	OC930-001-0x
SERCOS interface	This option card adds SERCOS interface capability to the base SC900.	OC940-001-01
Programmable	This option card adds programmable functionality to the base SC900.	OC950-50X-01
Connector Kits:		
All mating connectors w/D-sub	Includes all mating connectors for base unit. Screw terminal blocks for power and D-sub for signal. X designates drive power level.	CA90x
All mating connectors w/D-sub to TB adapter	Includes all mating connectors for base unit. Screw terminal blocks for power and D-sub to screw terminal adapter modules for signal.	CA90x-TB
Fan Kits:		
Fan kit for SC9x2/3/4	Adds forced air cooling to the SC9x2, SC9x3, SC9x4. Suffix -002 is for 240 Vac 50/60 Hz, -001 is for 120 Vac 60 Hz.	OF902-00x
Fan kit for SC9x3/4	Adds forced air cooling to the SC9x3/4. Suffix -002 is for 240 Vac 50/60 Hz, -001 is for 120 Vac 60 Hz.	OF903-00x OF903-00x OF904-00x
Manuals:		
SC900 base drive	Hardware reference manual for SC900 base drives.	MA900
OC930 option card	Hardware/software reference manuals for the serial communications option card.	MA930
OC940 option card	Hardware/software reference manuals for the SERCOS interface option card.	MA940
OC950 option card	Hardware/software reference manuals for the programmable single axis option card	MA950

HOW TO ORDER . . . SC900 Series Recommended Motor/Drive Systems

See Recommended Motor/Drives Systems table on page B-14 for performance information and model numbers for servo motor/drive combinations. Order motors and drives as separate part numbers.

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OC950 OPTION CARD

Programmable Single Axis Position Control Option Card

FEATURES

- New Windows® Development Environment
- Compiled ServoBasic™ Software
- Powerful Interactive Debugger
- Intel™ MicroController Inside
- 21 Programmable and Configurable I/O
- Optional Connection to Opto-22 I/O
- Optional PacLAN™ Local Area Network
- 32K NV Memory w/Optional 128K Available
- 8 Programmable Limit Switches w/Module
- Fully Adjustable Motion Profile Parameters
- Interrupts on Motion & Program Variables

BASIC PROGRAMMING LANGUAGE

Since first introducing a standard software programming tool like BASIC in a drive 1987, Pacific Scientific has continued to enhance the functionality and ease of use. The fourth generation OC950 and Windows® development with motion functions like `RunSpeed` and `IndexDist` integrated with standard `While:Wend` and `For:Next` statements to give you true motion programming flexibility. Why not use a language you know already?

WINDOWS DEVELOPMENT ENVIRONMENT

This development environment lets you program in modular blocks that can easily be re-used time and time again. The easy to use editor and powerful debugger with program variable watch windows make troubleshooting easy. Easy to use as a simple word processor, yet the structured text language controls the most complex machines.



CONFIGURABLE BI-DIRECTIONAL I/O

The OC950 has 21 digital I/O ports. These ports can be configured as either inputs or outputs. The ServoBasic program also has access to the SC900 base drive's six I/O for a total of 27 ports. The days of not having the right mix of inputs and outputs are over. This I/O can be used to interface to your PLC, or control machine sensors and other control devices. For fully flexible industrial I/O the OC950 ports are Opto-22 compatible.



FEATURES WHEN COMBINED WITH THE SC900 FAMILY OF BRUSHLESS SERVO DRIVES

- Completely Digital Set-Up and Tuning
- DSP Based Servo Control Algorithms
- Encoder Input and Encoder Output
- Analog Input and Two Analog Outputs
- Two High Speed Registration Inputs
- Digital Fault Code Information
- Full Protection and Diagnostics
- Ability to Run Linear Motors
- Exclusive Signature Current Control
- Patented DRDC Resolver ASIC
- Full Range of Servo Motors up to 800 lb-in

LOCAL AREA NETWORK OPTION

In addition to the standard RS232/485 Serial interfaces the OC950 can be ordered with Pacific Scientific's PacLAN™ interface. This is ideal for networking drives together. It is a 2.5 Mbaud token passing communications port where all variables and real time motor information can be passed from drive to drive. Connect up to 250 drives together with PacLAN™ and you still have your serial ports left over to communicate with your Man Machine Interface!

BUY ONLY WHAT YOU NEED

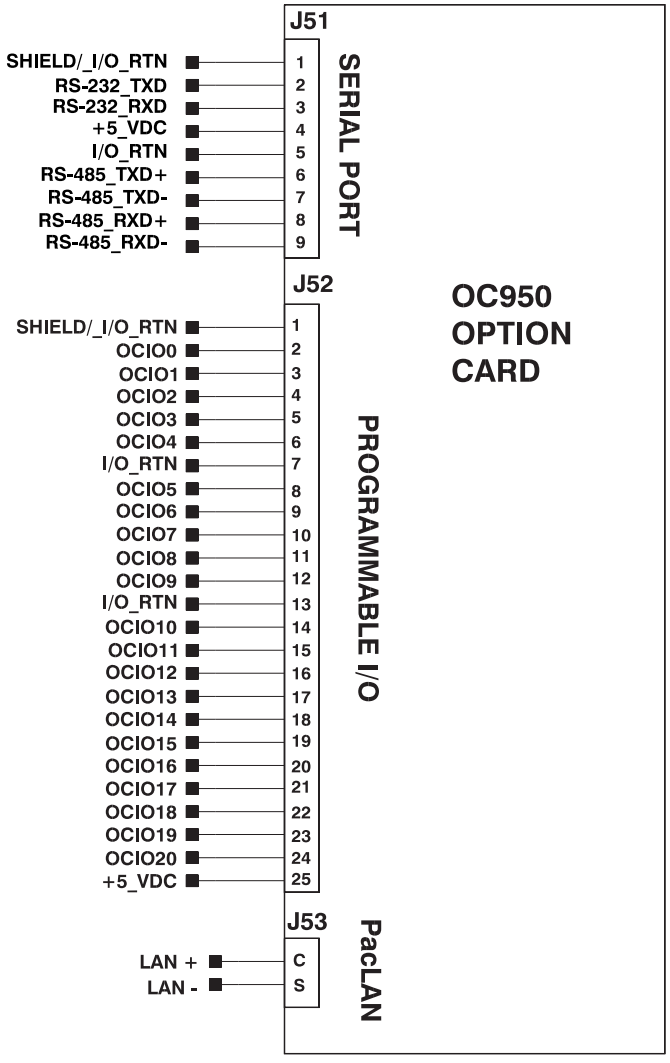
Like the rest of the SC900 Series products, the OC950 can be ordered with or without options. Modular ordering allows you to build up the options that suit your needs and not pay for extras you won't use. Even the Windows Development Environment is a one time purchase item for the cost conscious OEM.

ServoBASIC *Plus*™

For details on Pacific Scientific's ServoBASIC *Plus*™software, see pages B-35 through B-39. For programming examples using this language, see pages B-40 through B-47.

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DIMENSIONS in. (metric dimensions for ref. only)



HOW TO ORDER . . .OC950 Programmable Single Axis Option Card

Programmable Option Card
OC950-50X-01 (where X determines the hardware options)
- 501 - OC950 32Kx8 NV RAM, without PacLAN
- 502 - OC950 128Kx8 NV RAM, without PacLAN
- 503 - OC950 32Kx8 NV RAM, with PacLAN
- 504 - OC950 128Kx8 NV RAM, with PacLAN

Manuals
OC950 Option Card
- MA950-IDE - Hardware/Software reference manuals - plus Integrated Development Environment on 3.5” PC Disk

Connector Kits
- CA950-IO - OC950 Industrial I/O Rack interface adapter board

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OC940 OPTION CARD

OC940 OPTION CARD
DIGITAL FIBER OPTIC Single Axis SERCOS Option Card

FEATURES

· Fiber optic noise free environment.
· 32-bit performance
· SERCOS interface
· Intel™ MicroController inside
· 8 optically isolated inputs
· 8 optically isolated outputs
· Simplified interconnect
· Intelligent drive

When combined with the SC900 servo drive the OC940 option card is designed for use in distributed, multi-axis motion control systems utilizing the SERCOS (Serial Realtime Communications System) digital interface international standard. SERCOS replaces the +/- 10 volt analog servo command interface with a high speed, digital, fiber optic link. The SERCOS standard allows bi-directional flow of information. The control sends position, velocity and torque commands and the drive reports actual data back.

SERCOS

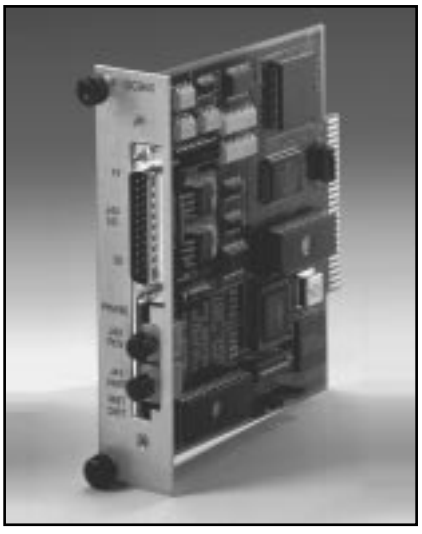
SERCOS is an open fiber optic based controller to digital drive interface international standard. The SERCOS interface is designed to communicate closed loop data serially in real time for high performance motion control systems. The SC900 control is a digital drive incorporating low cost digital signal processors (DSPs) that when combined with the OC940 option card exploit the most current innovations in motion control to date.

NOISE FREE ENVIRONMENT

A single fiber optic cable ring is the only connection necessary between the motion controller and the drives. Cable lengths of up to 100 meters can be achieved between controller and drive without any concern of signal corruption.

SIMPLIFIED INTERCONNECT

When compared to a conventional multi-axis motion system the OC940 offers a much simpler approach. A typical analog system requires many low voltage interconnects between the drive and controller. The troublesome task of running numerous wires throughout conduit and debugging them is reduced to running a single fiber optic cable. The wiring between motor and drive can be done local to where the motor is being used.



OPTICALLY ISOLATED I/O

The OC940 comes standard with 8 configurable optically isolated inputs and 8 optically isolated outputs. The I/O is 5 Vdc to 30 Vdc compatible.

INTELLIGENT DRIVE

The OC940 closes all it loops locally. The position, velocity and torque blocks are maintained within the drive. This allows the motion controller to be freed up to generate the motion profiles. Up to 16 axes of motion profiles can be updated every 2 mSeconds.

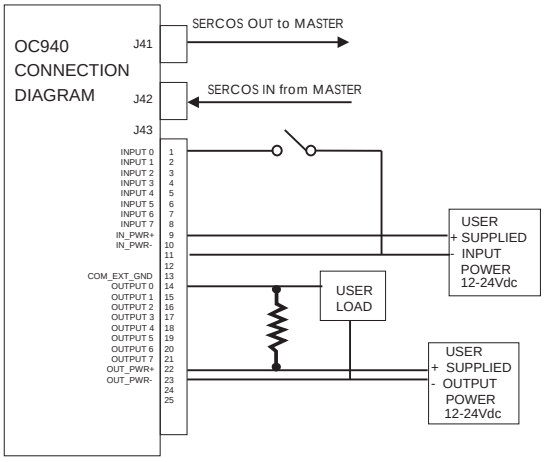
This 2 mSecond update rate should not be confused with the servo loop update rates. The servo loop update rates are controlled by the drives local processor. In traditional centralized systems, the profile generator update rate is typically not specified since this interface is buried within the controller.

HOW TO ORDER

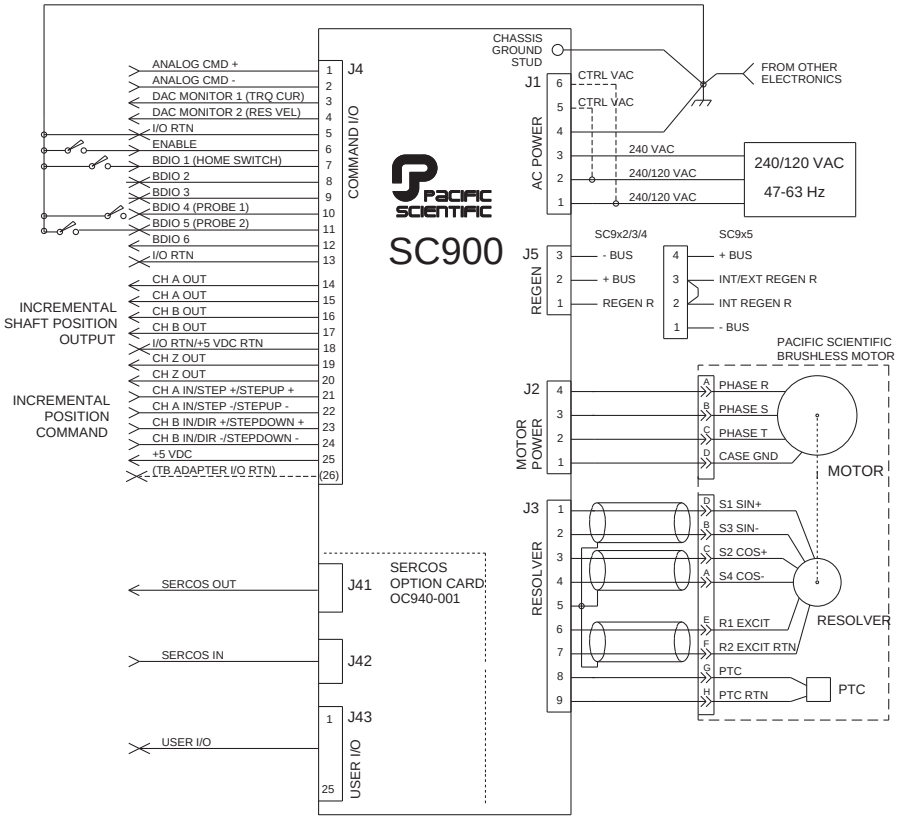
The OC940 option card is designed to plug in to any SC900 servo drive. See page B-22 for more details.

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CONNECTION DIAGRAM. . .Model OC940



CONNECTION DIAGRAM. . .Model SC940



HOW TO ORDER . . .OC940 Single Axis Option Card

SERCOS Option Card

OC940-001-01	SERCOS Option Card for SC900 Drives

Manuals

OC940 Option Card

MA940	Hardware & Software Reference Manual

Connector Kits

CA940	All mating connectors with D-sub signal connector
CA940-TB	All mating connectors with D-sub to terminal block adapter.

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HOW SERCOS WORKS-AN OVERVIEW

The SERCOS interface is implemented using a master-slave configuration, interconnected unidirectionally over a fiber optic cable, in a ring structure. The data transfer rate is 4 MBits/s with an update time of 2 msec.

The Pacific Scientific/Automation Intelligence programmable motion controller (or similar controller) is the master and the brushless drives with SERCOS option cards are the slaves. The motion controller controls the flow of information by sending out a synchronization “heartbeat” called the MST every 2 msec. See Figure B-5. All the slaves sequentially receive the MST.

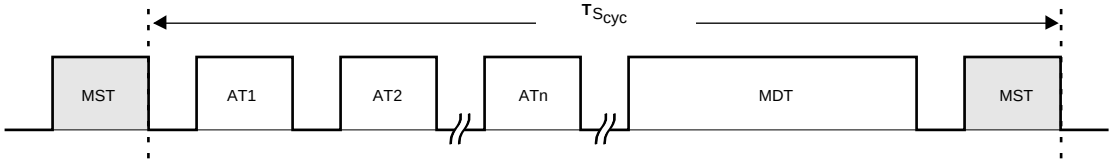


Figure B-5. SERCOS Master Synchronization Telegram-MST

The drives internally synchronize themselves to the MST clock and send back current drive information to the master during “time slot” intervals. This current drive information is contained in the Amplifier Telegram, or AT. (See Figure B-6). The AT is configurable, although it typically consists of time-critical data such as actual position, velocity and torque.

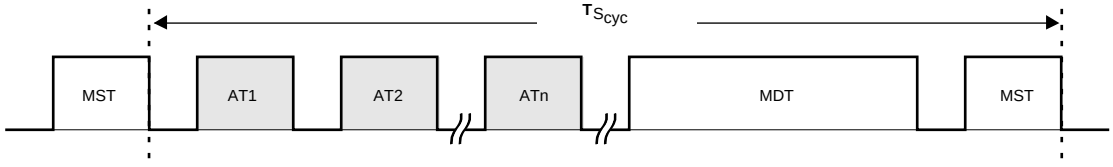


Figure B-6. SERCOS Amplifier Telegram-AT

At the end of each cycle, a Master Data Telegram, or MDT is sent to the slaves. See Figure B-7. The new command values for each drive on the ring are contained in this MDT.

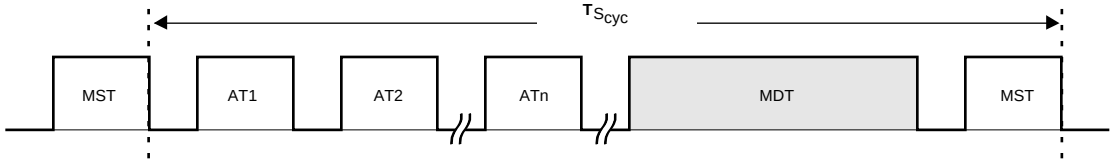


Figure B-7. Master Data Telegram-MDT

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IDENTIFICATION NUMBERS (IDN)

- All parameters defined as IDNs
  - — 32-bit integers
  - — Lists of other IDNs
  - — 16-bit Words
  - — Text
- IDN Definition Includes
  - — Value
  - — Description
  - — Attributes
  - — Min, Max
  - — Units

- The SERCOS Option Card supports the following IDNs as defined by the SERCOS standard. The SERCOS host controller and its software allow setting and reading of these IDNs.

1 Control Unit Cycle Time (TNcvc)
2 SYSTEM Interface Cycle Time (Tscvc)
3 Minimum AT Transmit Starting Time (TImin)
4 Transmit/Receive Transition Time (TATMT)
5 Minimum Feedback Acquisition Time (T4min)
6 AT Transmission Starting Time (TI)
7 Feedback Acquisition Starting Time (T4)
8 Command Valid Time (T3)
9 Beginning Address in Master Data Telegram
10 Length of Master Data Telegram
11 Class 1 Diagnostics
14 Interface Status
15 Telegram Type Parameter
16 Custom Amplifier Telegram Configuration List
17 IDN List of all Operation Data
24 Configuration List of the Master Data Telegram
32 Primary Mode of Operation
40 Velocity Feedback Value
41 Homing Velocity
42 Homing Acceleration
43 Velocity Polarity Parameter
44 Scaling of Velocity Data
45 Scaling Factor for Velocity Data
46 Scaling Exponent for Velocity Data
47 Position Command Value
51 Position Feedback Value 1 (Motor Feedback)
52 Actual Position Feedback 1-Reference Distance
55 Position Polarity Parameters
76 Position Data Scaling Method
77 Linear Position Data Scaling Factor
78 Linear Position Data Scaling Factor Exponent
79 Rotational Position Resolution
88 Receive to Receive Recovery Time (TMTSY)
89 MDT Transmit Starting Time (T2)
90 Command Value Transmit Time (TMTSG)
95 Diagnostic Message
99 Reset Class 1 Diagnostics
103 Modulo Value
108 Feedrate Override
123 Feed Constant
127 Communications Phase 3 Transition Check
128 Communications Phase 4 Transition Check
130 Actual Position Value Probe 1 Positive Edge
131 Actual Position Value Probe 1 Negative Edge
138 Bipolar Acceleration
147 Homing Parameter
148 Drive-Controlled Homing Procedure Command
160 Scaling Method for Acceleration Data
161 Scaling Factor for Acceleration Data
162 Scaling Exponent for Acceleration Data
169 Probe Control Parameter
170 Probing Cycle Procedure Command
185 Length of the Configurable Data Record in the AT
186 List of the Configurable Data Record in the MDT
187 List of the Configurable data in the AT
188 List of the Configurable data in the MDT
301 Allocation of Real-Time Control Bit 1
303 Allocation of Real-Time Control Bit 2
305 Allocation of Real-Time Status Bit 1
307 Allocation of Real-Time Status Bit 2
400 Home Switch
401 Probe 1
403 Position Feedback Value Status
405 Probe 1 Enabled
409 Probe 1 Positive Latched
410 Probe 1 Negative Latched

DIAGNOSTIC DATA

In addition to the real-time transmission between the control and drives, SERCOS also provides advanced diagnostic and fault information on the same fiber optic cable. Non time-critical data such as set up parameters, tuning coefficients and homing functions are available through the SERCOS service channel without connecting to any additional I/O. Also incorporated is an oscilloscope function that digitally captures and stores noise-free torque, velocity and position samples for later analysis.

GENERAL MOTION CONTROL

SERCOS was originally developed for machine tool applications. Later, SERCOS has evolved for general motion control and can control typical requirements such as:

- Point-to-point moves
- Electronic gearing
- Electronic CAM profiles
- Registration
- Measurements
- Electronic drive trains

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USER CONNECTIONS

- On SERCOS Option Card
  - —J41 SERCOS out to master
  - —J42 SERCOS in from master
  - —J43 8 inputs, 8 outputs
    Opto input power
    Opto output power

- On Host Servo Drive
  - —J3 Resolver Feedback and Motor PTC
  - —J2 Motor Power
  - —J1 AC Input
  - —J5 Regen
  - —J4-6 Enable
  - —J4-7 Home Iput
  - —J4-10 Probe 1
  - —J4-11 Probe 2

ADDRESS SELECTION DIP SWITCH

- Eight switches used for selecting the OC940 SERCOS address. Each servo drive on the SERCOS ring must be assigned a unique address.

SERCOS—QUESTIONS AND ANSWERS

What is SERCOS?

SERCOS (**SE**rial **R**eal-time **CO**mmunication **S**ystem) is an open fiber optic based controller to digital drive interface international standard. The SERCOS interface is designed to communicate closed loop data serially in real time for high performance motion control systems.

Why a digital standard?

Today, the purely digital drive system is becoming more prevalent. The digital servo drive has no analog circuits and uses no analog feedback loops. Incorporating low cost, high-performance digital signal processors (DSPs), this technology offers enhanced capability well beyond analog drives. But to fully exploit its potential, a well-defined and standardized digital interface must also be specified. The reason is that if a digital motion controller must control a digital drive, through an analog signal, resolution is sacrificed and noise sensitivity becomes an issue. Even if both digital units operate internally with numerical precision of 32 bits, A/D and D/A conversion typically occurs only at 12 to 16-bits, introducing electrical noise and thereby limiting the full capabilities of the drive.

What are the advantages of an open interface?

Proprietary, vendor specific digital interfaces have existed since the 1980s. However, they restrict the user to a single source for both drives and control. This limits the user's ability to select components based on application need and creates a substantial support burden when equipment from various suppliers must be maintained. Obviously, the motion control industry is best served in the long run by an open interface specification.

Who developed the standard?

SERCOS was initiated in 1987 by a group of European machine builders who were concerned about the impending problems of multiple digital interfaces. One of the stated goals of SERCOS is to ensure that the exchange of data required for utilizing digital drives does not obstruct individual development of drives and controls. It was developed jointly by the German Machine Tool Builders Association and the German Electrical and Electronic Manufacturers Association. These two associations have assembled major manufacturers of motors, drives and CNCs into a joint working group. Companies who have joined in the SERCOS working group include Pacific Scientific/Automation Intelligence, AEG, ABB, AMK, Baumuller, Bosch, Indramat, and Siemens.

How is SERCOS implemented?

The transmission medium is plastic fiber optic cable, implemented in a fiber optic ring currently running at 4 MB/s. The current SERCOS implementation permits up to 32 drives to be connected to one fiber optic ring with a position profile update time of 2 ms. The topology is a ring structure in which MASTER and SLAVES are connected unidirectionally. The MASTER controls and synchronizes the ring and a SLAVE can service one or multiple drives.

What about cost?

At the end of 1993, a SERCOS application specific integrated circuit (ASIC) was introduced. It simplifies product designs incorporating the SERCOS interface by handling the low-level protocol SERCOS communication link. The host control writes to a dual-port RAM in the ASIC, which then handles messaging, timing, and communications with the drives. The use of the ASIC raises the data transfer rate to 4 Mbits/s and reduces the per node cost of the interface. Calculations show that the costs for a SERCOS interface correspond to those of an analog interface for the same drive. There are significant savings with respect to the controls, since a number of drives can be connected to each SERCOS interface.

What are other advantages?

Beyond the obvious advantages of an open digital interface, the physical implementation is simple to install and maintain and will operate reliably in the factory environment with up to a 100m interconnection path between units.

The immense requirements for conduit, wiring and terminations, which are normally associated with an analog interface, are eliminated with SERCOS. So are the long manhour requirements typically associated with installing an analog interface. The fiber itself is the sole connection between the controller and the drives. Since everything runs along a single fiber network, cable and termination cost is virtually non-existent. In fact, fiber's inherent noise immunity means that it can even run in the same conduit that carries high voltage enabling.

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Is SERCOS close to adoption?

The Draft International Standard (DIS) has been submitted to the IEC. It is expected to be published as an international standard soon.

Is SERCOS just for machine tool/CNC applications?

Although originally envisioned and developed as a CNC to digital drive interface, this specification has proven itself to be widely applicable as an interface between general motion controls and digital drives. Industry has come to realize that all the basic primitives of general motion control can be implemented in a SERCOS ring—opening up vast new market potential.

SERCOS can be used effectively and efficiently to implement the following classes of general motion control functions:

- Point-to-Point Moves
- Electronic Gearing
- Electronic Cam Profiling
- Registration/Measurement
- Electronic Drive Trains

Where is SERCOS Specification headed?

Recently, industry has come to realize that all the basic primitives of general motion control can be implemented in a SERCOS ring, dispelling the myth that SERCOS is a viable standard only for CNC and machine tools. Numerous servo drive manufacturers have products either on the market or under development. With ASIC availability and IEC standardization, the technology will become more widely accepted in the motion control industry.

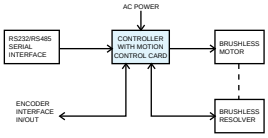
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SC750 SERIES*

Digital Programmable Position Controllers
3.8A to 60A continuous current
7.5A to 120A peak

Peak torque range: 10.0 to 800 lb-in. (1.1 to 90 Nm)





- Full digital control—featuring advanced commutation and position control methods
- Rugged single resolver feedback
- Digital auto-tuning for easy setup—**no** potentiometers to tweak
- Easy, flexible programming in ServoBASIC *Plus™*
- Turbo option features 50% faster program execution and 85K of program and data non-volatile user memory
- Extensive diagnostics to ease troubleshooting
- Total front access to clearly marked connections
- High speed (2.5 Mbaud) Local Area Network (PacLAN™) allows multiple axes to share information quickly
- 28 user programmable I/Os
- Standard 24K non-volatile user memory
- Inaudible, high frequency PWM current control
- Single and multi-axis use
- UL recognition

The SC750 Series brings fully digital, intelligent motion control to unforgiving industrial environments. In terms of reliability and performance, the SC750 anticipates real-world requirements.

Numerous technical innovations (patents pending) provide the SC750 with enormous application flexibility. These breakthroughs give you the best of both worlds: performance advantages previously limited to an analog implementation with digital precision, drift-free setup and operation.

Our ServoBASIC *Plus*™ software lets you program application-specific solutions with a high degree of comfort and confidence. Due to modular design, programming, wiring, setup and operation procedures are identical for all SC750 Series models.

With five power levels, the SC750 Series provides a position control capability to complement the SC720 torque/velocity controllers. When used in combination with Pacific Scientific brushless servo motors, SC750 Series controllers provide continuous torques ranging from 4.8 lb-in. to 451 lb-in. and peak torques from 10 lb-in. to 800 lb-in.

Standard motor power and feedback cables are available to complete your motion control system and provide reliable, troublefree startup and operation.

DIGITAL RESOLVER-TO-DIGITAL CONVERSION

A proprietary Resolver-to-Digital Conversion (RDC) process, Digital Resolver-to-Digital Conversion (DRDC) provides high-resolution digital velocity and position information for the SC750's microprocessor.

This technique (U.S. patent 5,162,798) has been implemented with dedicated digital signal processing (DSP) hardware for fast response. DRDC is the heart of the SC750's digital implementation.

Prior to DRDC, PacSci had refrained from the digital velocity loop compromise. Previous digital techniques offered freedom from drift and potentiometer setup—at the expense of excellent low speed smoothness and stiffness offered by analog tachometer feedback. With DRDC, motion control users can have the performance *and* setup capabilities they need.

SIGNATURE CURRENT CONTROL

The SC750 Series utilizes a patented Signature current control, a new, proprietary form of brushless motor commutation.

Brushless motors typically have a sinusoidal back EMF curve. However, this back EMF curve is never a pure sine wave. The result is torque ripple when the motor is driven with sinusoidal currents.

Pacific Scientific's Signature current control significantly reduces ripple torques due to distortion in the motor's back EMF waveform. By tailoring the sinusoidal current's wave shape or "signature" to match the motor's back EMF, ripple torque is reduced to ±2% or less.

Signature current control produces extremely low torque ripple at low speeds while retaining excellent high speed torque—a combination previously unavailable. In your application, this means excellent machine precision and smoothness with high throughput capability.

APPLICATION SPECIFIC INTEGRATED CIRCUITS

Application-specific integrated circuits (ASICs) make many of the SC750's powerful enhancements feasible on the factory floor. ASICs are cost effective and increase reliability by reducing component part count.

FULL DIGITAL CONTROL

All parameters required for system setup are digitally set in software. The SC750 Series has no potentiometers to tweak and no components to change.

Digital control assures reliable, repeatable, driftfree machine setup. Firmware running on a 16 bit microprocessor, coupled with the dedicated DRDC hardware, implements the DSP algorithms necessary for tight servo control.

SC750 Controllers are UL Recognized (File E137798)

**See pages B-6 through B-26 for information on the next generation Servo Position Control.*

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AUTOTUNING

In many applications, the autotuning feature will automatically set up the servo compensation parameters. You won't need oscilloscopes, meters or other instruments—just a personal computer—to set up your system. The system allows you to select the type of performance desired.

DIAGNOSTIC PROGRAMS

Numerous diagnostic programs are included to ease the task of system integration into your machine. These diagnostics also simplify troubleshooting.

LOCAL AREA NETWORK . . . PacLAN™

A 2.5 Mbaud, token passing communications port allows multiple axes to communicate and share information at high speed. PacLAN™ also serves as an expansion port for support of future SC750 enhancements.

The PacLAN port utilizes CRC error detection, message acknowledgement and a fully isolated cable driver for industrially reliable communications, even in high noise environments. See the programming example on page B-47.

IGBT PWM POWER STAGE

Insulated gate bipolar transistor (IGBT) technology is used in the power stage of every SC750 Series Controller. This technology makes exceptionally efficient use of high PWM frequencies (20 kHz). As a direct result, motor operation is more efficient and the annoyance of audible PWM noise is eliminated.

EXPANDABLE USER MEMORY

24K of battery-packed RAM user memory is standard for non-volatile storage of programs and setup variables.

For complex applications, the SC750 Turbo option offers 50% faster ServoBASIC *Plus* execution speed and provides 85K of battery backed RAM user memory. See "How to Order" on page B-34.

EXTENSIVE I/O

- 16 user programmable inputs
- 12 user programmable outputs
- Analog input
- Analog output
- 4 dedicated control inputs
- 5 dedicated control outputs

COMMUNICATIONS

- RS-232 interface, 9600 baud
- RS-485/422 interface, 9600 baud. Multidrop, up to full RS-485 capacity (32 nodes)
- PacLAN 2.5 Mbaud industrial Local Area Network allows interconnecting and sharing information among up to 254 nodes/axes

OPERATING FEATURES

- Smooth, high bandwidth position/velocity/torque control
- Transformerless, direct 240/120 Vac line operation
- IGBT PWM output stage
- Phoenix pluggable, screw terminal connections
- Fully enclosed, panel mount package
- Integral, directional dynamic braking

ADJUSTMENTS

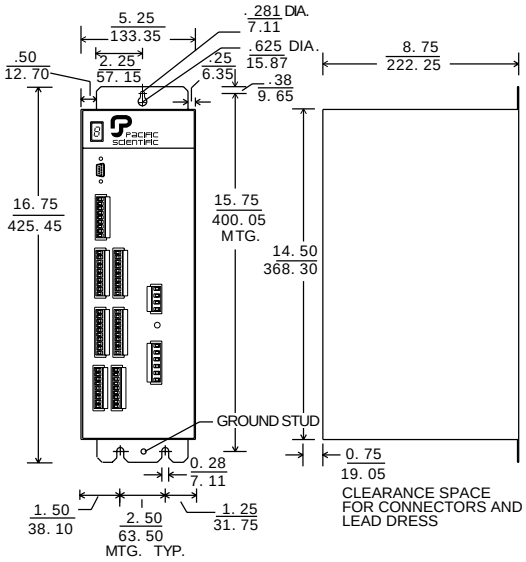
- 8 position DIP switch for PacLAN address
- No adjustments are required since all parameters are set in software

PROTECTION/DIAGNOSTICS

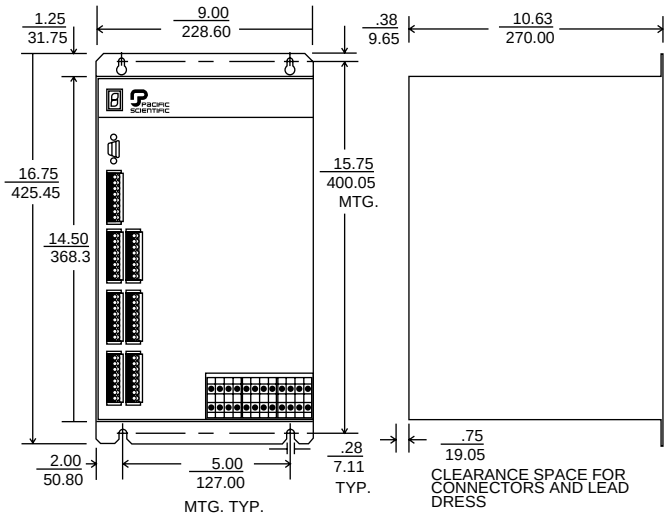
- 7 segment status/fault display
- Front access test points
- Inrush current limiting
- Fully fused
- MOV protected input
- Output short circuit protection
- Overtemperature protection, controller and motor
- I*T protection
- Programmable 4 bit fault code output

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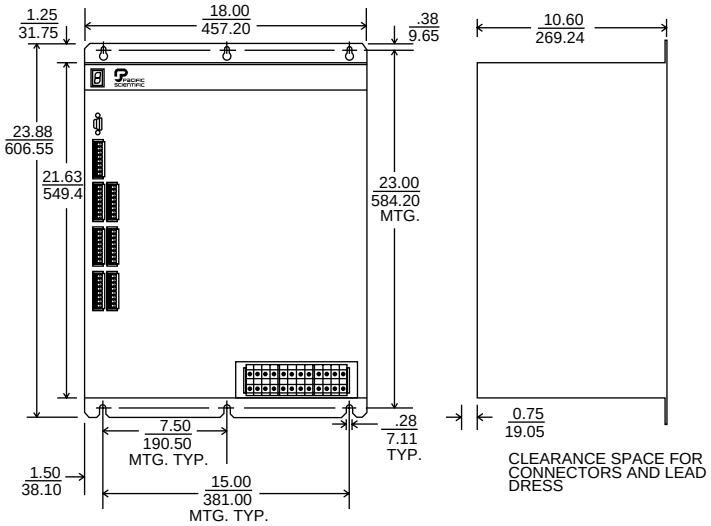
DIMENSIONS*



SC752/SC753



SC754/SC755



SC756

**See pages B-6 through B-26 for information on the next generation Servo Position Control.*

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GENERAL . . .SC750 Series Controllers*

Efficiency (50% output voltage, rated cont. current)	>95%
Form factor	<1.01
Current loop bandwidth	1500 to 3000Hz
Input command	RS-232 or RS-485/422, PacLAN port
Output ripple frequency (±15%)	20 kHz
Position resolution	65,536 steps/rev (16 bit)
Position accuracy (drive only)	
Standard	± 22 arcmin
Optional	± 4 arcmin
Velocity range (drive only)	0 to 12,000 RPM
Analog input	±12 Vdc range, 16 bit @200 Hz bandwidth or 14 bit @1000 Hz bandwidth, 0.25% linearity, 50μV/°C drift, fully monotonic, 60 mV offset, 100 Kohm input impedance
Analog output	±5 Vdc range, 12 bit, updated every 0.4 mS, fully monotonic, 50 ohm source impedance
Control inputs	Enable Fault reset Inhibit + Inhibit -
Control outputs	Fault Current monitor Commutation signal Two +5V @250 mA max.
Programmable inputs	12 general purpose 2 general purpose/fast 2 general purpose/counter Optically isolated, 5 to 24 Vdc logic, sourcing; fast inputs have 5μS max. capture time
Programmable outputs	11 general purpose 1 general purpose/PWM 5 to 24 Vdc logic, open collector sinking, up to 100 mA
Encoder Emulation	
Modes	Encoder output Encoder input Step/direction input
Encoder output mode	Quadrature with marker pulse, differential TTL line driver, software selectable resolution—500, 512, 1000, 1024, 2000, 2048, 4096, 16,384 PPR, 750 kHz max.
Encoder input mode	Quadrature with marker pulse, differential TTL line receivers, 750 kHz max.
Step/direction mode	Differential TTL line receivers, 750 kHz max.
Mating connectors (furnished)	All plug-in mating connectors
Storage temperature	-55°C to 70°C
Operating temperature	
Full ratings	0°C to 50°C
Derated⚠	50°C to 60°C
Altitude	5000 ft. (1500 m)
Humidity	10% to 90%, non-condensing
Weight	SC752, 13 lbs. SC753, 16 lbs. SC754/755, 40 lbs SC756, 90 lbs.

⚠ Linearly derate the continuous current and power ratings to 70% at 60°C.

**See pages B-6 through B-26 for information on the next generation Servo Position Control.*

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POWER DATA. . .SC750 Series Controllers*

	SC752	SC753	SC754	SC755	SC756
Input voltage					
Control logic power	90 to 264 Vac, 47 to 63 Hz, 1 phase				
Bus power	120 Vac (+ 10%, -15%)/ 240 Vac (+ 10%, -15%), 47 to 63 Hz, 1 or 3 phase		240 Vac (+ 10%, -15%), 47 to 63 Hz, 3 phase		
Bus Voltage					
(with 240 Vac input)	320 Vdc				
(with 120 Vac input)	160 Vdc				
Input current[3]					
Control logic power	500 mA max. @ 115 Vac, 250 mA max. @ 230 Vac.				
Bus current (RMS) (230 Vac, 3-phase)	4.5 A_{rms}	9 A_{rms}	18 A_{rms}	29 A_{rms} (@6kW)	38 A_{rms} (@ 12kW)
Output current @ 50°C[1]					
Peak (5 seconds)	7.5 A	15 A	30 A	60 A	120 A
Continuous (stall)	3.8 A	7.5 A	15 A	30 A[2]	60 A
Output power (min. @ 50°C)					
Peak (5 seconds)					
230 Vac, 3-phase	2.2 kW	4.5 kW	9 kW	18 kW	36 kW
230 Vac, 1-phase	2.0 kW	4.0 kW	n/a	n/a	n/a
Continuous					
230 Vac, 3-phase	1.1 kW	2.2 kW	4.5 kW	9 kW	18 kW
230 Vac, 1-phase	0.8 kW	1.6 kW	n/a	n/a	n/a
Shunt regulator power					
Peak	3 kW	6 kW	20 kW	20 kW	40 kW
Continuous	20 W	40 W	200 W	200 W	500 W

[1] Currents shown are the peak of a sinewave. Multiply by 0.707 to get RMS current value.

[2] The SC755 can be configured for 40 A continuous (stall).

[3] Input current is specified with unit operating at continuous rated output power.

**See pages B-6 through B-26 for information on the next generation Servo Position Control.*

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SC750 SERIES RECOMMENDED MOTOR/CONTROLLER SYSTEMS[6]

Peak stall torque T_{PS}[1] lb-in./Nm	Peak rated torque T_{PR}[2] lb-in./Nm	Cont. stall torque T_{CS} lb-in./Nm	Cont. rated torque T_{CR} lb-in./Nm	Rated Speed W_R[3] rpm	Inertia x 10^{-3}[4] lb-in-S^2/ kgm² J	Servo-motor Dia. or Width/height inch/mm	Servo-motor Length inch/mm	Inductance line-line L mH	Servo-motor model	Servo-Controller model[5]
With R Series (low inertia, rare earth magnet) motors										
10/ 1.1	6.5/ .7	4.8/ .5	2.5/ .3	8000	0.12/ .014	2.00/ 50.8	7.38/187.5	5.3	R22HENA-R1-NS-NV-01	SC752A-001-01
14/ 1.6	8/ .9	7.6/ .9	5.2/ .6	8000	0.15/ .017	2.00/ 50.8	8.38/212.9	6.5	R23HENA-R1-NS-NV-01	SC752A-001-01
17/ 1.9	10/ 1.1	9.2/ 1.0	7.1/ .8	6000	0.18/ .020	2.00/ 50.8	9.38/238.3	6.5	R24HENA-R1-NS-NV-01	SC752A-001-01
27/ 3.0	25/ 2.8	14/ 1.6	10/ 1.1	4000	0.55/ .062	3.25/ 82.6	7.09/180.1	23.0	R32GENC-R2-NS-NV-00	SC752A-001-01
27/ 3.0	25/ 2.8	14/ 1.6	6/ .7	7000	0.55/ .062	3.25/ 82.6	7.09/180.1	5.8	R32HENC-R2-NS-NV-00	SC753A-001-01
36/ 4.0	33/ 3.7	21/ 2.4	16/ 1.8	3000	0.74/ .084	3.25/ 82.6	8.09/205.5	22.0	R33GENC-R2-NS-NV-00	SC752A-001-01
36/ 4.0	25/ 2.8	21/ 2.4	10/ 1.1	6000	0.74/ .084	3.25/ 82.6	8.09/205.5	5.6	R33HENC-R2-NS-NV-00	SC753A-001-01
45/ 5.0	42/ 4.7	27/ 3.0	24/ 2.7	2800	0.92/ .104	3.25/ 82.6	9.09/230.9	30.0	R34JENC-R2-NS-NV-00	SC752A-001-01
45/ 5.0	38/ 4.3	27/ 3.0	16/ 1.8	4000	0.92/ .104	3.25/ 82.6	9.09/230.9	7.5	R34KENC-R2-NS-NV-00	SC753A-001-01
54/ 6.0	53/ 5.9	32/ 3.6	30/ 3.4	2000	1.11/ .125	3.25/ 82.6	10.09/256.3	42.0	R35JENC-R2-NS-NV-00	SC752A-001-01
54/ 6.0	48/ 5.4	32/ 3.6	23/ 2.6	3000	1.11/ .125	3.25/ 82.6	10.09/256.3	10.5	R35KENC-R2-NS-NV-00	SC753A-001-01
66/ 7.4	50/ 5.6	33/ 3.7	33/ 3.4	1800	1.90/ .215	4.25/108.0	8.34/211.8	53.0	R43GENA-R2-NS-NV-00	SC752A-001-01
66/ 7.4	60/ 6.7	33/ 3.7	31/ 3.5	3000	1.90/ .215	4.25/108.0	8.34/211.8	13.3	R43HENA-R2-NS-NV-00	SC753A-001-01
106/11.9	95/10.6	48/ 5.4	46/ 5.2	2000	2.70/ .305	4.25/108.0	9.84/249.9	4.9	R45GENA-R2-NS-NV-00	SC753A-001-01
106/11.9	95/10.6	48/ 5.4	43/ 4.8	4000	2.70/ .305	4.25/108.0	9.84/249.9	20.0	R45HENA-R2-NS-NV-00	SC754A-001-01
142/15.9	120/13.4	64/ 7.2	61/ 6.8	1500	3.50/ .395	4.25/108.0	11.34/288.1	25.0	R46GENA-R2-NS-NV-00	SC753A-001-01
142/15.9	120/13.4	64/ 7.2	50/ 5.6	3000	3.50/ .395	4.25/108.0	11.34/288.1	6.2	R46HENA-R2-NS-NV-00	SC754A-001-01
150/16.8	125/14.0	70/ 7.8	58/ 6.5	3000	7.10/ .818	5.75/146.1	9.36/237.7	8.9	R63GENA-R2-NS-NV-00	SC754A-001-01
150/16.8	142/15.9	70/ 7.8	38/ 4.3	6000	7.10/ .818	5.75/146.1	9.36/237.7	2.2	R63HENA-R2-NS-NV-00	SC755A-001-01
240/26.9	230/25.8	115/12.9	102/11.4	1700	11.10/1.28	5.75/146.1	11.36/288.5	13.7	R65GENA-R2-NS-NV-00	SC754A-001-01
240/26.9	200/22.4	115/12.9	90/10.1	3000	11.10/1.28	5.75/146.1	11.36/288.5	3.4	R65HENA-R2-NS-NV-00	SC755A-001-01
340/38.1	305/34.2	168/18.8	156/17.5	1000	15.10/1.74	5.75/146.1	13.36/339.3	18.2	R67GENA-R2-NS-NV-00	SC754A-001-01
340/38.1	330/37.0	168/18.8	146/16.4	2000	15.10/1.74	5.75/146.1	13.36/339.3	4.6	R67HENA-R2-NS-NV-00	SC755A-001-01
300/33.6	280/31.4	190/21.3	125/14.0	3800	39.10/4.50	7.50/190.5	10.93/277.6	3.2	R84GENA-R2-NS-NV-00	SC755A-001-01
300/33.6	270/30.2	190/21.3	45/ 5.0	6000	39.10/4.50	7.50/190.5	10.93/277.6	0.8	R84HENA-R2-NS-NV-00	SC756A-001-01
410/45.9	395/44.2	276/30.1	225/25.2	2000	58.10/6.69	7.50/190.5	12.93/328.4	3.6	R86GENA-R2-NS-NV-00	SC755A-001-01
410/45.9	365/40.9	276/30.1	120/13.4	4000	58.10/6.69	7.50/190.5	12.93/328.4	0.9	R86HENA-R2-NS-NV-00	SC756A-001-01
540/60.5	525/58.8	357/28.8	325/36.4	1500	76.10/8.77	7.50/190.5	14.93/379.2	4.0	R88GENA-R2-NS-NV-00	SC755A-001-01
540/60.5	500/56.0	357/28.8	205/23.0	3000	76.10/8.77	7.50/190.5	14.93/379.2	1.0	R88HENA-R2-NS-NV-00	SC756A-001-01
800/89.6	730/81.8	451/50.5	424/47.5	1200	95.10/10.96	7.50/190.5	16.93/430.0	7.4	R8AGENA-R2-NS-NV-00	SC755A-001-01
800/89.6	720/80.6	451/50.5	300/33.6	2000	95.10/10.96	7.50/190.5	16.93/430.0	1.9	R8AHENA-R2-NS-NV-00	SC756A-001-01
With F Series (medium inertia, ferrite magnet) motors[6]										
56/ 6.3	34/ 3.8	32/ 3.6	25/ 2.8	1500	9.20/1.04	4.25/108.0	8.34/211.8	49.0	F43GENA-R2-NS-NV-00	SC752A-001-01
60/ 6.7	30/ 3.4	32/ 3.6	22/ 2.5	3000	9.20/1.04	4.25/108.0	8.34/211.8	12.0	F43HENA-R2-NS-NV-00	SC753A-001-01
84/ 9.4	55/ 6.2	46/ 5.2	43/ 4.8	1000	13.70/1.55	4.25/108.0	9.84/249.9	69.0	F45FENA-R2-NS-NV-00	SC752A-001-01
84/ 9.4	45/ 5.0	46/ 5.2	38/ 4.3	2000	13.70/1.55	4.25/108.0	9.84/249.9	17.0	F45GENA-R2-NS-NV-00	SC753A-001-01
121/13.6	62/ 6.9	61/ 6.8	48/ 5.4	1500	17.70/2.00	4.25/108.0	11.34/288.1	24.0	F46GENA-R2-NS-NV-00	SC753A-001-01
121/13.6	60/ 6.7	61/ 6.8	43/ 4.8	3000	17.70/2.00	4.25/108.0	11.34/288.1	6.0	F46HENA-R2-NS-NV-00	SC754A-001-01

[1] See page B-73 for definitions of ratings.

[2] Peak torque ratings are for 5 seconds.

[3] Rated speeds are for 230 Vac, 3 phase operation.
Derate to approximately 85% for 240 Vac, 1 phase operation.
Derate to 40% for 115 Vac, 1 phase operation.

[4] Includes primary feedback inertia.

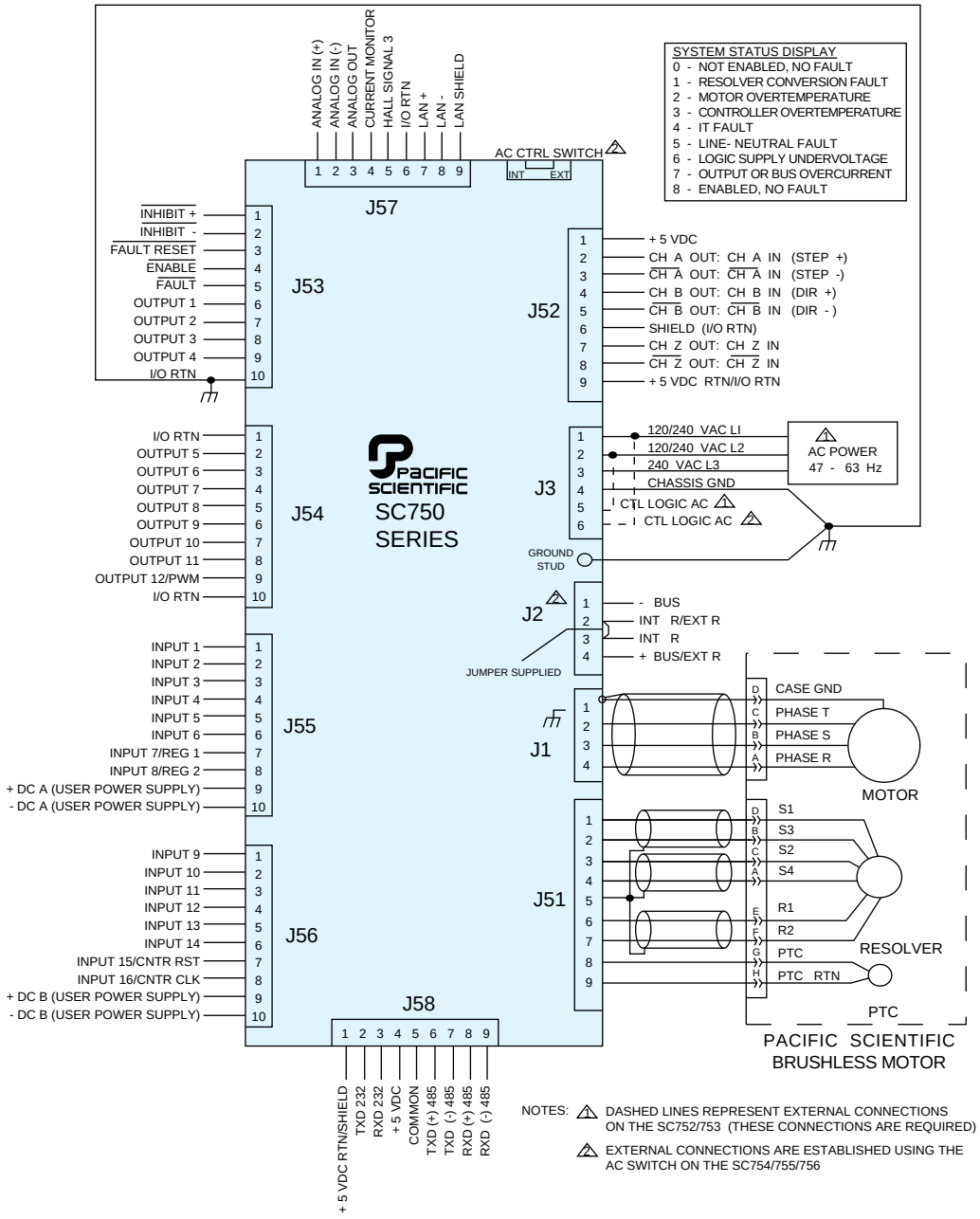
[5] Controller model numbers are for 12 bit resolution option.
See "How to Order" on page B-34.

[6] Each system requires one feedback and one motor power cable.

**See pages B-6 through B-26 for information on the next generation Servo Position Control.*

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CONNECTION DIAGRAM . . . SC750 Series Controllers*



**See pages B-6 through B-26 for information on the next generation Servo Position Control.*

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HOW TO ORDER . . . SC750 Series Controllers*

To order an SC750 Series brushless servo motor controller, designate the power level and position accuracy desired. The next three digits are a controller customization code, which is factory assigned. It is also used to specify any customer requested modifications. The final two digits specify the desired software option.

For a standard SC750 Series controller with a power rating of 15A cont., 30A peak, the following model number would be ordered:

MODEL NUMBER CODE

SC 7 5 4 A-001-01

Servo controller

Series

Function code
5=position controller (resolver)

Power level code
2=3.8A cont./7.5A peak
3=7.5A cont./15A peak
4=15A cont./30A peak
5=30A cont./60A peak
6=60A cont./120A peak

Option code
A=12 bit RDC (±22 arcmin, 1024 ppr)
B=14 bit RDC (±4 arcmin, 4096 ppr)

Customization code
Factory assigned, 001=standard unit

Suffix code
-01=PacSci ServoBASIC *Plus*™ programming language with 24K user memory
-02=PacSci ServoBASIC *Plus*™ programming language with 100K user memory and faster processor

HOW TO ORDER . . .SC750 Series Recommended Motor/Controller Systems

See the Recommended Motor/Controller Systems table on page B-32 for performance information and model numbers for servo motor/controller combinations. Order motors and controllers as separate part numbers. See brushless servo motor section for additional motor specifications and information.

**See pages B-6 through B-26 for information on the next generation Servo Position Control.*

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PACIFIC SCIENTIFIC'S ServoBASIC *Plus*™

Pacific Scientific developed ServoBASIC™ as a subset of the popular GWBASIC by adding motion control commands.. With the ServoBASIC™ language, intelligent motion control became accessible to users with little or no programming experience.

First introduced in 1987, ServoBASIC™ has helped engineers do sophisticated motion and machine control in thousands of applications. The second generation ServoBASIC Plus™ was introduced with the SC750 family of drives. The SC750 ServoBASIC Plus™ was the logical progression of the original breakthrough, enhanced through field experience and faster microprocessors. The third generation of ServoBASIC Plus™ fits on the OC950 option card for the SC900 family of all digital servo drives. Each generation of ServoBASIC™ has expanded flexibility and functionality, increased execution speed, and simplified programming. Throughout each generation we have retained the familiar syntax and program flow of ServoBASIC, so you don't have to learn a new language to access the enhanced power and flexibility.

Advantages of the OC950 third generation ServoBASIC Plus™

- 5 times faster program execution than previous generation• 27 fully programable bidirectional digital inputs/outputs• 8 programmable position limit switches
- PacLAN™ inter drive communications is optional• Fully integrated Windows program development environment
- Enhanced program modularity:
  - Arguments to subroutines
  - Local variables
  - User defined functions
  - Fast multi-way branches
  - Multi dimensional array variables
- Full interactive debugger

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ABORT.MOTION
Stops motor motion while allowing continued program execution.

ABS
Converts the associated value (x) to an absolute value.

ACCEL.GEAR
Sets the commanded acceleration rate when gearing is turned ON. The specified acceleration rate is used until GEARLOCK is achieved. ACCEL.GEAR is independent of DECEL.GEAR.

ACCEL.RATE
Sets the maximum commanded acceleration rate when speed is increased.

ACCEL.TYPE
Determines the use of constant acceleration or S-Curve velocity profiles.

AD.OFFSET
Specifies the level of a signal summed with the digitized value of the analog input channel, in volts.

ADF0
Sets the analog input channel's filter break frequency.

ANALOG.IN
Contains the digitized value of the analog input channel, in volts, of J57-1 relative to J57-2.

ANALOG.OUT
Sets the voltage level of the analog output channel.

ARF0
The first anti-resonant filter break frequency.

ARF1
The second anti-resonant filter break frequency.

ASC( )
Returns a numeric value that is the ASCII code for the first character of the string expression.

ATAN
Returns the arctangent of x in radians.

AUTOSTART
Specifies the automatic execution of a user program as soon as the servo controller has AC power applied.

AXIS.ADDR
Indicates the RS-485 or multidrop address set by switch S1 on the controller.

AXIS.INTR
Indicates the axis address number of the source address of a LANINTERRUPT.

BEEP
Transmits a speaker beep command to the serial port.

BLKTYPE
Specifies configuration as a position, velocity or torque block.

CALL
Transfers program execution to a BASIC subroutine.

CCWINH
Indicates the current state of the CCWINH (INH-) input.

CCWOT
Sets the counter-clockwise overtravel limit.

CHR$( )
Converts an ASCII code to its equivalent character.

CINT( )
Converts x to an integer by rounding the fractional portion.

CLS
Clears the screen display of a terminal.

CMDGAIN
Controls the scale factor of the analog input signal to the servo loops for BLKTYPE=0, 1, or 3.

CONST
Declares numeric constants to be used in place of numeric values.

COS( )
Returns the cosine of its argument which must be in radians.

COUNTER
Specifies the current count of the hardware event counter feature using discrete input 16.

COUNTSPERREV
Specifies the resolution of the position control.

CWINH
Indicates the current state of the CWINH (INH+) input.

CWOT
Sets the clockwise overtravel limit.

DACMAP
Specifies the signal sent to the monitor DAC driving the analog output channel.

DACMON
Contains the value of the selected, filtered variable output to the analog output channel.

DECEL.GEAR
Sets the deceleration rate commanded when gearing is turned OFF. The specified deceleration rate is used until geared motion has stopped. ACCEL.GEAR is independent of DECEL.GEAR.

DECEL.RATE
Sets the maximum deceleration rate commanded when speed is decreased.

DIM
Specifies and allocates storage for variables and arrays.

DIR
Sets the direction the motor turns when a GO.VEL function is executed.

DMF0
Sets the analog output channel's filter break frequency.

DMGAIN
Specifies the multiplicative scale factor applied to analog output signal when DACMAP=0.

ENABLE
Allows or prevents power flow to the motor.

ENABLED
Indicates whether the controller is enabled.

ENC.FREQ
Contains the frequency in quadrature pulses per second of the external encoder input averaged over a 128 msec interval for filtering.

ENC.IN
Specifies the line count of the encoder being used for electronic gearing.

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PACSCI SERVOBASIC *Plus*™ COMMAND SUMMARY VERSION 2.7... Cont.

ENC.OUT
Selects the direction of encoder ports and selects emulated encoder line count when the bidirectional encoder ports are set to “transmit.”

ENCPOS
Indicates the position of the external encoder.

END
Marks the end of a program, subroutine, IF...THEN...ELSE block structure or interrupt service routine.

EXIT
Used to exit a subroutine, an interrupt, FOR...NEXT or WHILE...WEND block structure.

FAULTCODE
Indicates the status of the controller.

FIX( )
Returns the truncated integer part of x.

FOR...NEXT
Allows a series of statements to be executed in a loop a given number of times.

FVEL.ERR
Indicates the velocity servo error signal, in RPM, after it has been processed by the anti-resonant filter section.

FWV
Indicates the controller firmware version number.

GEARERROR
Specifies the amount of position lag that accumulates when electronic gearing is turned on.

GEARING
Turns electronic gearing on or off and sets allowed direction of motion.

GEARLOCK
Indicates slave axis velocity is synchronized with the master, when performing electronic gearing.

GO.ABS
Causes the motor to move to the position specified by TARGET.POS.

GO.HOME
Moves the motor shaft to the electrical home position.

GO.INCR
Moves the motor shaft an incremental index from the current position.

GO.VEL
Moves the motor shaft at a constant speed.

GOSUB...RETURN
Branches program execution to a subroutine, executes it, and returns.

GOTO
Causes software to jump to a specific label and continue executing.

HEX$( )
Converts a long integer to a hexadecimal ASCII string.

ICMD
Indicates the commanded motor torque current in amperes.

IFB
Indicates the measured motor current amplitude in amperes.

IF...THEN...ELSE
Statements control program execution based on the evaluation of numeric expressions.

ILC
Sets the current loop proportional gain.

ILMT.MINUS
Sets the maximum allowable current in the counter-clockwise direction.

ILMT.PLUS
Sets the maximum allowable current in the clockwise direction.

INDEX.DIST
Sets the distance which the motor rotates during each incremental index.

INKEY$( )
Returns one character read from the serial port’s buffer.

IN.POS.LIMIT
Specifies the tolerance of commanded position minus action position within which region the position limit flag will be set.

IN.POSITION
Indicates whether or not the motor has achieved commanded position.

INPn
Reads the state of an individual discrete input.

INPUT
Reads a character string received by the serial communications port, terminated by a carriage return.

INPUTS
Reads the state of discrete inputs.

INSTR( )
Provides the location of a substring within a string.

INT( )
Truncates an expression to a whole number.

INTERRUPT
Marks the beginning and the end of an interrupt service routine.

INTR.{source label}
Used to enable and disable the interrupts.

IPEAK
Contains the peak current rating of the controller in amperes.

IFT0
Specifies the corner frequency of the low pass filter implementing the IT controller thermal protection circuit.

IT.FILT
Contains the output of the I*T controller thermal protection filter circuit.

IT.THRESH
Designates the threshold (trip level) at which the IT thermal protection triggers an overcurrent fault.

KPP
Sets the proportional gain of the position loop in Hz.

KTEFF
Torque constant of the system in lb-in/amp.

KVFF
Sets the proportion of velocity feedforward signal added to the velocity command from differentiated position command.

KVI
Sets the integral gain of the velocity servo loop.

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KVP
Sets the proportional gain of the velocity servo loop.

LANFLT(1-32)[axis]
Shared user floating point variables for inter-axis communication. 32 variables per controller on the PacLAN network.

LANFLT(n) [axis#]
An array of 32 floating point variables globally accessible over PacLAN.

LANINT(1-32) [axis]
Shared user integer variables for inter-axis communication. 32 variables per controller on the PacLAN network.

LANINT(n) [axis#]
An array of 32 integer variables globally accessible over PacLAN.

LANINTERRUPT [axis#]
Invokes an interrupt to the PacLAN controller specified by [AXIS#].

LCASE$( )
Converts expression to lower case characters.

LEFT$( )
Returns a string of the leftmost characters of a string.

LEN( )
Returns the number of characters in the string.

LTRIM$( )
Removes the leading blank characters from a string expression.

LOG( )
Returns natural logarithm value.

LOG10( )
Returns base 10 logarithm of expression.

LOGGEDON
Indicates that the controller has been selected as the enabled multidrop subsystem by the multidrop master.

MID$( )
Replaces a portion of a string with another string.

MODEL
Indicates the servo controller model number.

MOVING
Indicates when a commanded motion profile has been completed.

OUTn
Sets the state of the individual discrete output.

OUTPUTS
Specifies the state of the discrete outputs.

PAUSE
Causes the program to pause the amount of time specified by the PAUSE.TIME variable.

PAUSE.TIME
Defines the length of time delay during a pause statement.

POLECOUNT
Matches the controller for the appropriate motor pole count.

POS.CHKn
Specifies the position at which outputs 1, 2 and 3 are switched to the polarity designated by POS.CHKn.OUT.

POS.CHKn.OUT
Used in conjunction with POS.CHKn to implement position check n.

POS.COMMAND
Contains the current position command.

POS.ERROR
Equal to the difference between the position command and the actual position.

POSITION
Indicates the actual motor position.

PRINT
Displays output on the terminal screen while the program is running.

PULSES.IN
Specifies the number of input encoder counts used for selecting an exact gear ratio.

PULSES.OUT
Specifies the number of resolver counts the motor will move for a specified number of encoder counts.

PWM12
Specifies the function of discrete output 12/PWM as a Pulse Width Modulated (PWM) signal and controls the duty cycle.

RATIO
Sets the electronic gearing ratio (rev/rev) between the encoder shaft and the motor shaft.

REG.DIST
Sets the distance that is moved automatically when a resolver registration input is applied.

REG.ENCPOS
Records the encoder position when an encoder registration input triggers.

REG.FLAG
Indicates that the registration input has triggered.

REG.FUNC
Specifies whether REG.DIST is the distance that is moved automatically when a resolver registration input is applied.

REG.MODE
Specifies the discrete input signal used to trigger and latch the encoder and resolver positions during registration.

REG.POS
Records the motor position when a resolver registration input triggers.

REG.RESPOS
Records the resolver position relative to the motor housing when a resolver registration input triggers.

REM or '
Designates explanatory remarks or comments in the program.

RESPOS
Contains the mechanical orientation of the resolver relative to the motor housing.

RESTART
Re-initializes the servo controller and commences execution after encountering an interrupt or program execution has become nested within levels of subroutines.

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RIGHT$( )
Returns the rightmost characters of the string.

RUN.SPEED
Sets the maximum speed used in making an incremental or an absolute move.

RVEL
Indicates the actual speed at which the motor shaft is rotating.

SGN( )
Returns the sign of x.

SIN( )
Returns the sine of its argument in radians.

SPACE$( )
Returns a string of spaces.

SQR( )
Returns the square root of an expression.

STATUS[axis#]
A read-only software variable that can be used within a program to determine if an external axis is connected to PacLAN.

STEPDIR
Specifies response to either quadrature encoder signals or step and direction input signals when electronic gearing is in use.

STOP
Stops the execution of the program.

STR$( )
Returns a string representation of the value of a numeric expression.

STRING$( )
Returns a string containing the specified number of occurrences of a character.

SUB
Defines the beginning and ending of a subroutine.

SWAP
Exchanges the values of two variables.

TAN( )
Returns the tangent of its argument in radians.

TARGET.POS
Sets the target position used with the GO.ABS function.

TIME
Contains the current value, in seconds, of a free running timer that is maintained by the internal software.

TMENABLEn
Enables or disables the programmable timers.

TMOUTn
Indicates the state of an output controlled by a programmable timer.

TMRSET
Specifies the operation of the programmable timers.

UCASE$( )
Converts value to upper case.

UPD.MOVE
Updates a move in progress with new variables.

VAL( )
Returns the numerical value of the string.

VEL.CMD
Indicates the net velocity servo loop command signal in RPM.

VEL.ERR
Indicates the velocity servo error signal in RPM.

VELOCITY
Indicates the actual speed at which the motor shaft is rotating averaged over a 128 msec interval.

WHEN
Used for very fast output response to certain input conditions.

WHEN.ANALOG.IN
Records the digitized value of the analog input channel, in volts, at the time the WHEN statement is satisfied.

WHEN.DACMON
Records the value of the selected, filtered variable output to the analog output channel at the time the WHEN statement is satisfied.

WHEN.ENCPOS
Records the encoder position at the time the WHEN statement is satisfied.

WHEN.ICMD
Records the commanded motor torque current, in amperes, at the time the WHEN statement is satisfied.

WHEN.IFB
Records the measured motor current amplitude, in amperes, at the time the WHEN statement is satisfied.

WHEN.PCMD
Specifies the motor position when the WHEN condition is satisfied.

WHEN.POS
Set to the value of POSITION when the WHEN condition is satisfied.

WHEN.RESPOS
Records the resolver's mechanical orientation relative to the motor housing at the time the WHEN statement is satisfied.

WHEN.RVEL
Records the raw motor velocity at the time the WHEN statement is satisfied.

WHEN.TIME
Records the variable TIME at the time the WHEN statement is satisfied.

WHEN.VELCMD
Records the net velocity servo loop command signal, in rpm, at the time the WHEN statement is satisfied.

WHILE...WEND
Tells the program to execute a series of statements as long as an expression after the WHILE statement is true.

WVSHP
Integer composed of the ASCII codes for the characters in the name of the motor back EMF wave shape that the controller is using to shape the motor current.

The following arithmetic operators are supported:

ADDITION +

DIVISION /

EXPONENTIATION ^

MODULO DIVISION %

MULTIPLICATION *

SUBTRACTION -

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These are actual program elements demonstrating the power of PacSci ServoBASIC *Plus*™ to easily program complex motion profiles.

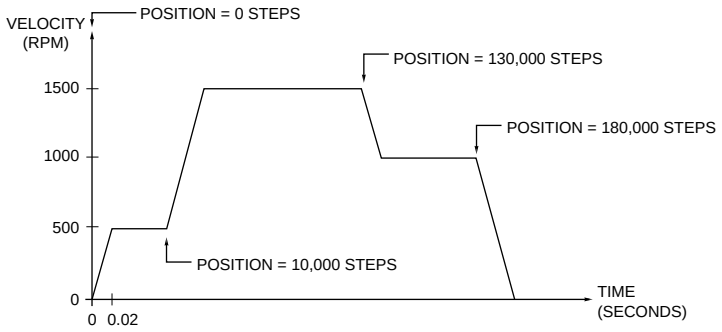
There's so much functionality in PacSci ServoBASIC *Plus* that you may never need to tap its full potential. If there's a software solution to your problem, our applications engineering people will find it.

BASIC PROGRAMMING EXAMPLES

EXAMPLE 1...Velocity change on position events

This program produces a multiple level velocity profile. Velocity changes are initiated based upon position events.

Program line	Comments
SETUP:	
ACCEL.RATE = 25000	SET ACCEL RATE TO 25,000 RPM/S
DECEL.RATE = 25000	SET DECEL RATE TO 25,000 RPM/S
RUN.SPEED = 500	SET RUN SPEED TO 500 RPM
IN.POS.LIMIT = 10	SET IN POSITION LIMIT TO ± 10 STEPS
HOME:	
GO.HOME	GO TO HOME POSITION
WHILE IN.POSITION < >1	WAIT FOR HOMING COMPLETE
WEND	
PROFILE:	
GO.VEL	START PROFILE, GO TO 500 RPM
RUN.SPEED = 1500	SET RUN SPEED TO 1500 RPM
WHILE POSITION <10000	WAIT FOR POSITION OF 10,000 STEPS
WEND	
GO.VEL	GO TO 1500 RPM
RUN.SPEED = 1000	SET RUN SPEED TO 1000 RPM
WHILE POSITION <130000	WAIT FOR POSITION OF 130,000 STEPS
WEND	
GO.VEL	GO TO 1000 RPM
RUN.SPEED = 0	SET RUN SPEED TO 0 RPM
WHILE POSITION <180000	WAIT FOR POSITION OF 180,000 STEPS
WEND	
GO.VEL	GO TO 0 RPM
END	END PROGRAM



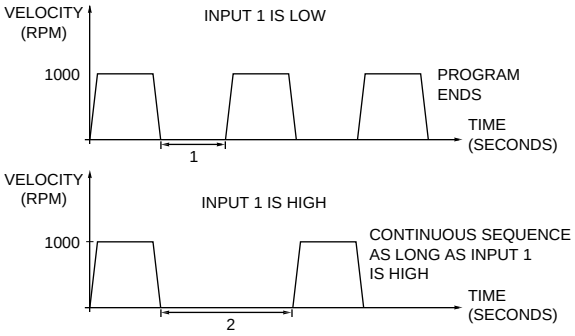
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BASIC PROGRAMMING EXAMPLES (Cont.)

Example 2. . .Jump on input

Here, the IF. . .THEN command is used to test a discrete input and take action depending upon the state of the input. The jumps in the program depend upon the state of Input 1.

Program line	Comments
SETUP:	
ACCEL.RATE = 10000	SET ACCEL TO 10,000 RPM/S
DECEL.RATE = 10000	SET DECEL RATE TO 10,000 RPM/S
RUN.SPEED = 1000	SET RUN SPEED TO 1,000 RPM
INDEX.DIST = 70000	SET INDEX DISTANCE TO 70,000 STEPS
READINPUT:	
IF INP1 THEN	IF INPUT 1 IS HIGH
PAUSE.TIME = 2	SET PAUSE TIME TO 2 SECONDS
GO.INCR	DO INDEX MOVE
WHILE MOVING = 1:WEND	WAIT TO COMPLETE MOVE
PAUSE	PAUSE 2 SECONDS
GOTO READINPUT	GO BACK TO READ INPUT 1 AGAIN
ELSE	IF INPUT 1 IS LOW
PAUSE. TIME = 1	SET PAUSE TIME TO 1 SECOND
FOR X = 1 TO 3	SET UP LOOP TO COUNT 3 INDEXES
GO.INCR	DO INDEX MOVE
WHILE MOVING = 1:WEND	WAIT TO COMPLETE MOVE
PAUSE	PAUSE 1 SECOND
NEXT	LOOP UNTIL 3 INDEXES COMPLETE
END IF	END IF. . .THEN. . .ELSE BLOCK
END	END PROGRAM



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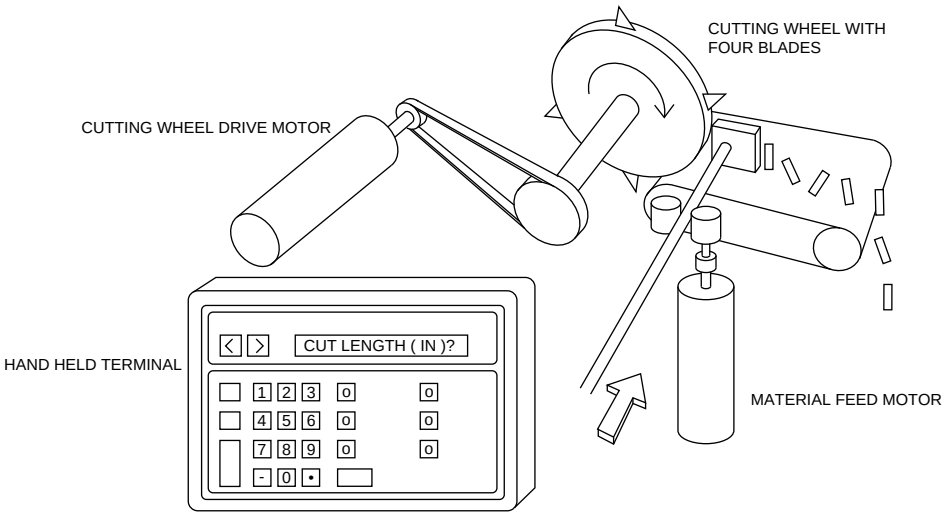
EXAMPLE 3. . .Cut-to-length operation

In this application, a rotary cut-to-length machine uses a short PacSci ServoBASIC *Plus*™ program to control independent cutting wheel and material feed axes.

This program drives an industrial terminal, such as the PacSci T10. The user is prompted for feed rate in inches per second and desired cut length in inches. The program then computes the required feed roll motor velocity based on feed roller diameter.

The cutting wheel motor runs at the computed speed as long as Input 1 is True. If Input 1 is brought False, the motor stops and the user is prompted for a new value.

Program line	Comments
SETUP:	
ACCEL.RATE = 10000	SET ACCEL TO 10,000 RPM/S
DECEL.RATE = 10000	SET DECEL RATE TO 10,000 RPM/S
DIR = 1	SET DIRECTION TO COUNTER CLOCKWISE
ENABLE = 1	SOFTWARE MOTOR ENABLE ON
PROMPTINPUTS:	
INPUT “FEED RATE (IN/SEC)”;FEEDRATE	PROMPT USER FOR INPUT
INPUT “CUT LENGTH (IN)”;CUTLENGTH	PROMPT USER FOR INPUT
PROFILE:	
RUN.SPEED = 75*FEEDRATE/CUTLENGTH	CALCULATE RUN SPEED
WHILE INP = 0	WHILE INPUT 1 IS LOW
GO.VEL	RUN AT CALCULATED SPEED
WEND	
ABORT.MOTION	STOP WHEN INPUT 1 IS HIGH
GOTO PROMPTINPUTS	PROMPT USER FOR NEW PARAMETERS



Cut-to-Length Machine

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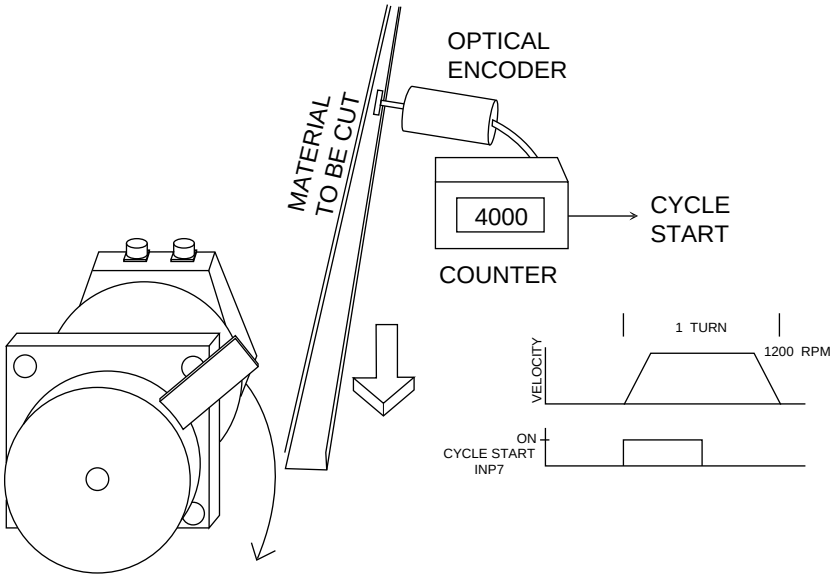
EXAMPLE 4. . .Using WHEN for rapid response

The PacSci ServoBASIC *Plus*™ instruction WHEN will help you achieve high speed response to inputs.

This program rotates a cutting blade one full revolution on the off-to-on transition of input INP7. WHEN ensures that the incremental move is initiated within one millisecond of the input transition.

Typically, the cut command is derived from an encoder and counter, which measure length of material passing the blade.

Program line	Comments
SETUP:	
ACCEL.RATE = 40000	SET ACCEL TO 40,000 RPM/S
DECEL.RATE = 40000	SET DECEL RATE TO 40,000 RPM/S
RUN.SPEED =1200	SET RUN SPEED TO 1200 RPM
INDEX.DIST = 4096	SET INDEX DISTANCE TO 4096 STEPS
IN.POS.LIMIT = 100	SET IN POSITION LIMIT TO ± 100 STEPS
OUTPUTS = 4095	SET ALL OUTPUTS OFF (HIGH)
PAUSE.TIME = 1	SET PAUSE TIME TO 1 SECOND
ENABLE = 1	SOFTWARE MOTOR ENABLE ON
NOTENABLED:	
WHILE ENABLE = 0	IF ENABLE INPUT IS NOT ACTIVE
OUT1 = 0	BLINK OUTPUT 1 ON (LOW)
PAUSE	FOR 1 SECOND
OUT1 = 1	AND OFF (HIGH)
PAUSE	FOR 1 SECOND
WEND	UNTIL ENABLE INPUT IS ACTIVATED
MOVE:	
OUT7 = 0	TURN OUTPUT 7 ON (LOW)
WHILE INP7 = 0:WEND	WAIT FOR INPUT 7 TO GO HIGH
WHEN INP7 = 0, GO.INCR	MOVE WHEN INPUT 7 GOES LOW
OUT7 = 1	TURN OUTPUT 7 OFF (HIGH)
WHILE IN.POSITION < >1:WEND	WAIT FOR MOVE COMPLETE
GOTO MOVE	GO BACK TO MOVE



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EXAMPLE 5. . .Programmable limit switches (cont. on next page)

The following program generates a motion profile typical of transfer line slide drives.

Because absolute positioning is required, homing to a mechanical home limit switch is initiated by an off-to-on transition of input INP7. The mechanical home limit switch is connected to INP1. The SEEK_HOME subroutine supports the mechanical homing operation and establishes the zero position (POS.COMMAND = 0) electrical reference.

Outputs OUT2 and OUT3 are programmed as “programmable limit switches” using the POS.CHK commands. They indicate, within two milliseconds, whether actual position is above or below specified values.

For example, OUT2 could signal the bed drive that the tool is fully withdrawn and the workpiece can now be transferred to the next station.

OUT4 is programmed to be on whenever the tool is in the workpiece. Such an output might be used to control cooling fluid.

The HOME block initiates the homing function on a high to low transition of input 7. In the SETLIMITS block, the function of the limit switches is established.

TRANSFER LINE SLIDE DRIVE PROGRAM

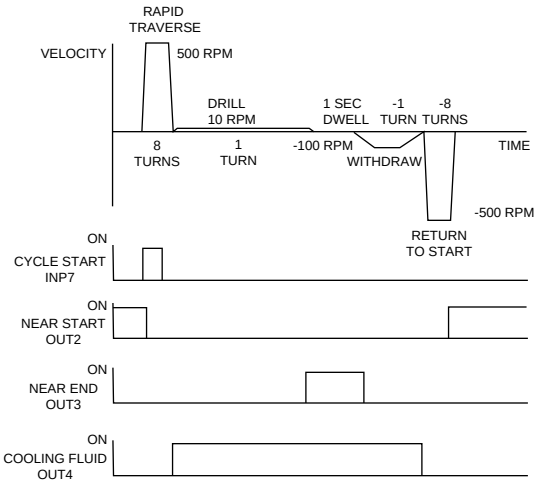
Program line	**Comments**
INITIALSETUP:	
ACCEL.RATE = 10000	SET ACCEL TO 10,000 RPM/S
DECEL.RATE = 10000	SET DECEL RATE TO 10,000 RPM/S
RUN.SPEED = 100	SET RUN SPEED TO 100 RPM
OUTPUTS = 4095	SET ALL OUTPUTS OFF (HIGH)
PAUSE.TIME = 1	SET PAUSE TIME TO 1 SECOND
POS.CHK1.OUT = 0	TURN OFF POSITION CHECK 1
POS.CHK2.OUT = 0	TURN OFF POSITION CHECK 2
POS.CHK3.OUT = 0	TURN OFF POSITION CHECK 3
DIR = 1	SET DIRECTION TO COUNTER CLOCKWISE
ENABLE = 1	SOFTWARE MOTOR ENABLE ON
NOTENABLED:	
WHILE ENABLED < > 1	IF ENABLE INPUT IS NOT ACTIVE
OUT1 = 0	BLINK OUTPUT 1 ON (LOW)
PAUSE	FOR 1 SECOND
OUT1 = 1	AND OFF (HIGH)
PAUSE	FOR 1 SECOND
WEND	UNTIL ENABLE INPUT IS ACTIVATED
HOME:	
OUT7 = 0	TURN ON (LOW) OUTPUT 7
WHILE INP7 = 0:WEND	WAIT FOR INPUT 7 TO GO HIGH
WHILE INP7 = 1:WEND	WAIT FOR INPUT 7 TO RETURN LOW
OUT7 = 1	TURN OFF (HIGH) OUTPUT 7
DIR = 1	
RUN.SPEED = 1000	
CALL SEEK__HOME	
SET LIMITS:	
POS.CHK2 = 8392	SET POSITION CHECK 2 AT 8392 STEPS
POS.CHK3 = 44856	SET POSITION CHECK 3 AT 44,856 STEPS
POS.CHK2.OUT = 11	OUTPUT 2 ON WHEN POSITION < POS.CHK2
POS.CHK3.OUT = 10	OUTPUT 3 ON WHEN POSITION > POS.CHK3
MOVETOSTART:	
ACCEL.RATE = 10000	SET ACCEL TO 10,000 RPM/S
RUN.SPEED = 500	SET RUN SPEED TO 500 RPM
TARGET.POS = 8192	SET TARGET POSITION TO 8192 STEPS
IN.POS.LIMIT = 10	SET IN POSITION LIMIT TO ± 10 STEPS
OUT4 = 1	TURN OUTPUT 4 OFF (HIGH)
GOSUB ABSMOVE	GO TO MOVE SUBROUTINE
OUT7 = 0	TURN OUTPUT 7 ON (LOW)
WHILE INP7 = 0:WEND	WAIT FOR INPUT 7 TO GO HIGH
OUT7 = 1	TURN OUTPUT 7 OFF (HIGH)
RAPIDTRAVERSE:	
ACCEL.RATE = 10000	SET ACCEL RATE TO 10,000 RPM/S
RUN.SPEED = 500	SET RUN SPEED TO 500 RPM
TARGET.POS = 40960	SET TARGET POSITION TO 40,960 STEPS
IN.POS.LIMIT = 50	SET IN POSITION LIMIT TO ± 50 STEPS
OUT4 = 1	TURN OUTPUT 4 OFF (HIGH)
GOSUB ABSMOVE	GO TO MOVE SUBROUTINE

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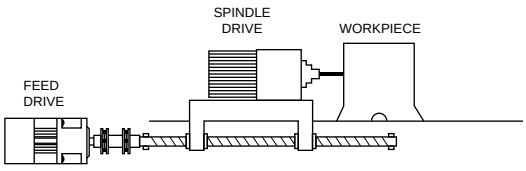
EXAMPLE 5. . .Programmable limit switches (cont. from prev. page)

Program line	Comments
DRILL:	
ACCEL.RATE = 1000	SET ACCEL RATE TO 1000 RPM/S
RUN.SPEED = 10	SET RUN SPEED TO 10 RPM
TARGET.POS = 45056	SET TARGETED POSITION TO 45,056 STEPS
IN.POS.LIMIT = 5	SET IN POSITION LIMIT TO ± 5 STEPS
OUT4 = 0	TURN OUTPUT 4 ON (LOW)
GOSUB ABSMOVE	GO TO MOVE SUBROUTINE
PAUSE	PAUSE FOR 1 SECOND
WITHDRAW:	
ACCEL.RATE = 1000	SET ACCEL RATE TO 1000 RPM/S
RUN.SPEED = 100	SET RUN SPEED TO 100 RPM
TARGET.POS = 40910	SET TARGET POSITION TO 40,910 STEPS
IN.POS.LIMIT = 50	SET IN POSITION LIMIT TO ± 50 STEPS
OUT4 = 0	TURN OUTPUT 4 ON (LOW)
GOSUB ABSMOVE	GO TO MOVE SUBROUTINE
GOTO MOVETOSTART	GO BACK TO START
GO.ABS	DO ABSOLUTE MOVE
WHILE NOT IN.POSITION:WEND	WAIT UNTIL MOVE COMPLETE
RETURN	RETURN TO GOSUB
END	

```
SIMPLIFIED SEEK__HOME ROUTINE
REM HOME SWITCH IS ACTIVE ON FALLING EDGE (CLOSES). THIS ROUTINE
REM COMMANDS MOTION UNTIL SWITCH SIGNAL GOES LOW, THEN REVERSES
REM DIRECTION AND DETERMINES LOCATION OF LOW-TO-HIGH
REM SWITCH SIGNAL (OPENING SWITCH) AND
REM ESTABLISHES ELECTRICAL HOME (POS.COMMAND = 0).
SUB SEEK__HOME
  GO.VEL
  RUN.SPEED = 0
  WHEN INP1 = 0, GO.VEL
  WHILE MOVING = 1:WEND
  IF DIR = 1 THEN DIR = 0 ELSE DIR = 1
  RUN.SPEED = 5
  GO.VEL
  RUN.SPEED = 0
  WHEN INP1 = 1, GO.VEL
  POS.COMMAND = POS.COMMAND = WHEN.PCMD
  END SUB
```



SLIDE DRIVE (MACHINE TOOL FEED)

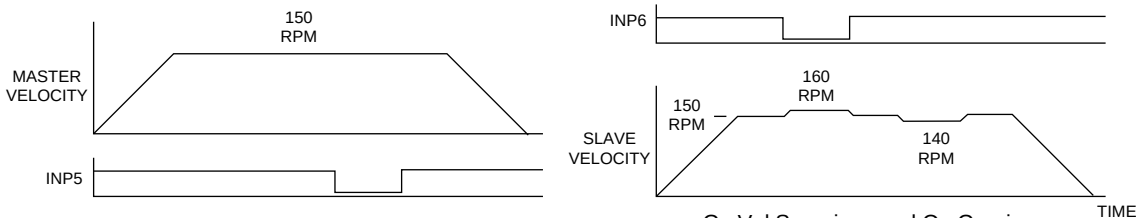


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EXAMPLE 6. . .Electronic gearing

In electronic gearing, a slave axis is electronically geared to a master. The master has a 1024 line encoder and is used in quadrature to produce 4096 transitions per revolution. The slave accepts 4096 transitions per revolution for a one to one ratio with the master. Electronic gearing is activated by an off to on transition of INP7.

Program line	Comments
SETUP:	
OUTPUTS = 4095	TURN ALL OUTPUTS OFF (HIGH)
GEARING = 0	TURN ALL ELECTRONIC GEARING OFF
ENC.OUT = 1024	SET FOR 1024 PPR ENCODER
RATIO = 1	SET ELECTRONIC GEAR RATIO TO 1:1
ACCEL.RATE = 10000	SET ACCEL TO 10,000 RPM/S
DECEL.RATE = 100000	SET DECEL RATE TO 100,000 RPM/S
RUN.SPEED = 10	SET RUN SPEED TO 10 RPM
OUT7 = 0	TURN OUTPUT 7 ON (LOW)
PAUSE.TIME = 1	SET PAUSE TIME TO 1 SECOND
ENABLE = 1	SOFTWARE MOTOR ENABLE ON
NOTENABLED:	
WHILE ENABLED < > 1	IF ENABLE INPUT IS NOT ACTIVE
OUT1 = 0	BLINK OUTPUT 1 ON (LOW)
PAUSE	FOR 1 SECOND
OUT1 = 1	AND OFF (HIGH)
PAUSE	FOR 1 SECOND
WEND	UNTIL ENABLE INPUT IS ACTIVATED
GEARINGON:	
WHILE INP7 = 0:WEND	WAIT FOR INPUT 7 TO GO HIGH
WHILE INP7 = 1:WEND	WAIT FOR INPUT 7 TO RETURN LOW
GEARING = 1	TURN ELECTRONIC GEARING ON
OUT7 = 1	TURN OUTPUT 7 OFF (HIGH)
OUT5 = 0	TURN OUTPUT 5 ON (LOW)
OUT6 = 0	TURN OUTPUT 6 ON (LOW)
DIRECTION:	
IF INP6 = 0 THEN	IF INPUT 6 IS LOW, SET
DIR = 0	DIRECTION OF 10 RPM VELOCITY TO CW
GO.VEL	SUPERIMPOSE 10 RPM ONTO GEARING
GOTO DIRECTION	GO BACK TO LOOK AT INPUT 6
END IF	END IF. . .THEN BLOCK
IF INP5 = 0 THEN	IF INPUT 5 IS LOW, SET
DIR = 0	DIRECTION OF 10 RPM VELOCITY TO CCW
GO.VEL	SUPERIMPOSE 10 RPM ONTO GEARING
GOTO DIRECTION	GO BACK TO LOOK AT INPUT 6
END IF	END IF. . .THEN BLOCK
ABORT.MOTION	STOP SUPERIMPOSED 10 RPM VELOCITY
GOTO DIRECTION	GO BACK TO LOOK AT INPUT 6



Go.Vel Superimposed On Gearing

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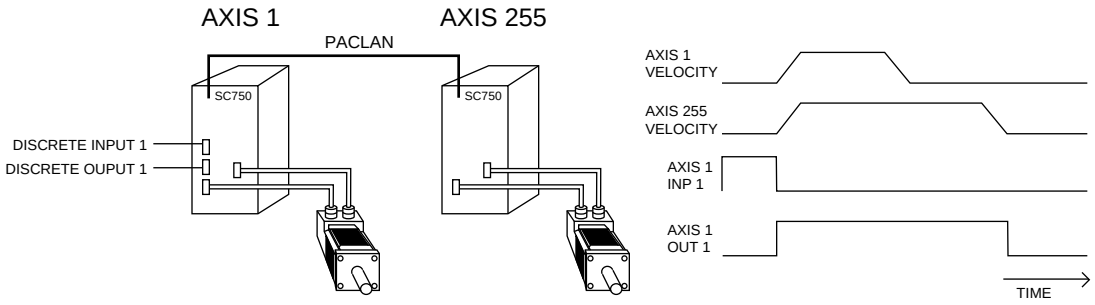
ADVANCED PROGRAMMING EXAMPLES (Cont.)

EXAMPLE 7. . .PacLAN™ Multi-axis position control capability using SC750 single axis digital position controllers

The PacLAN™ enhancement is a local area network (LAN) system that allows multiple single axis SC750 controllers to be integrated to provide effective and economical solutions to many multi-axis motion control applications. SC750 controllers networked via PacLAN provide distributed motion control and replace centralized multi-axis controllers. Using PacLAN, information can be exchanged with any SC750 controller on the network. Easy application monitoring and adjustments are made using a single operator interface or a host computer.

The 2.5 megabaud PacLAN allows up to 255 axes (nodes) to communicate and share information at distances up to 500 feet. PacLAN is a token passing communications port that utilizes CRC error detection, message acknowledgement, rugged twinaxial cabling and a fully transformer-isolated cable driver for reliable communications in high noise industrial environments.

This example shows the ease of synchronized motion in two axes with an input to the first axis.



The program for axis 1 waits for a one-to-zero transition of its discrete input 1 before initiating a ten turn incremental move. Similarly, axis 255 waits for the same transition to initiate a 20 turn incremental move. The program in axis 255 indicates that it is looking at an input to axis 1 by using the variable name “INP1[1].” The bracketed “1” is a call to PacLAN to fetch the data from axis 1 over the network. The network is also used to insure that both axes are in position before another move can be initiated.

AXIS 1

Program line	Comments
OUTPUTS = 4095	TURN OFF ALL OUTPUTS
ACCEL.RATE = 10000	SETUP AXIS 1 MOVE PARAMETERS
DECEL.RATE = 10000	
RUN.SPEED = 500	
INDEX.DIST = 10 * 4096	
IN.POS.LIMIT = 10	
PAUSE.TIME = .1	ENABLE AXIS 1 CONTROLLER
ENABLE = 1	
PAUSE	
WHILE 1 = 1	MAIN PROGRAM LOOP
OUT1 = 0	TELL THE WORLD BOTH AXES ARE HOLDING POSITION
WHILE INP1 = 0:WEND	DO INCREMENTAL MOVE ON HIGH-TO-LOW TRANSITION OF INP1
WHILE INP1 = 1:WEND	
OUT1 = 1	INDICATE MOTION IN PROCESS
GO.INCR	INITIATE MOVE
WHILE((IN.POSITION = 0) OR (IN.POSITION [255] = 0))	WAIT TILL BOTH AXES ARE AT POSITION
WEND	
WEND	
END	MAIN PROGRAM

AXIS 255

Program line	Comments
ACCEL.RATE = 10000	SETUP AXIS 255 MOVE PARAMETERS
DECEL.RATE = 10000	
RUN.SPEED = 500	
INDEX.DIST = 20 * 4096	
IN.POS.LIMIT = 10	
PAUSE.TIME = .1	ENABLE AXIS 255 CONTROLLER
ENABLE = 1	
PAUSE	
WHILE 1 = 1	MAIN PROGRAM LOOP
WHILE INP1[1] = 0:WEND	DO INCREMENTAL MOVE ON HIGH-TO-LOW TRANSITION OF AXIS 1’S INP1
WHILE INP1[1] = 1:WEND	
GO.INCR	
WHILE((IN.POSITION = 0) OR (IN.POSITION [1] = 0))	WAIT TILL BOTH AXES ARE AT POSITION
WEND	
WEND	
END	MAIN PROGRAM

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